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INVERTEBRATE MEGAFOSSILS
OF THE BELVEDERE EXPEDITION
TO THE GULF OF CALIFORNIA

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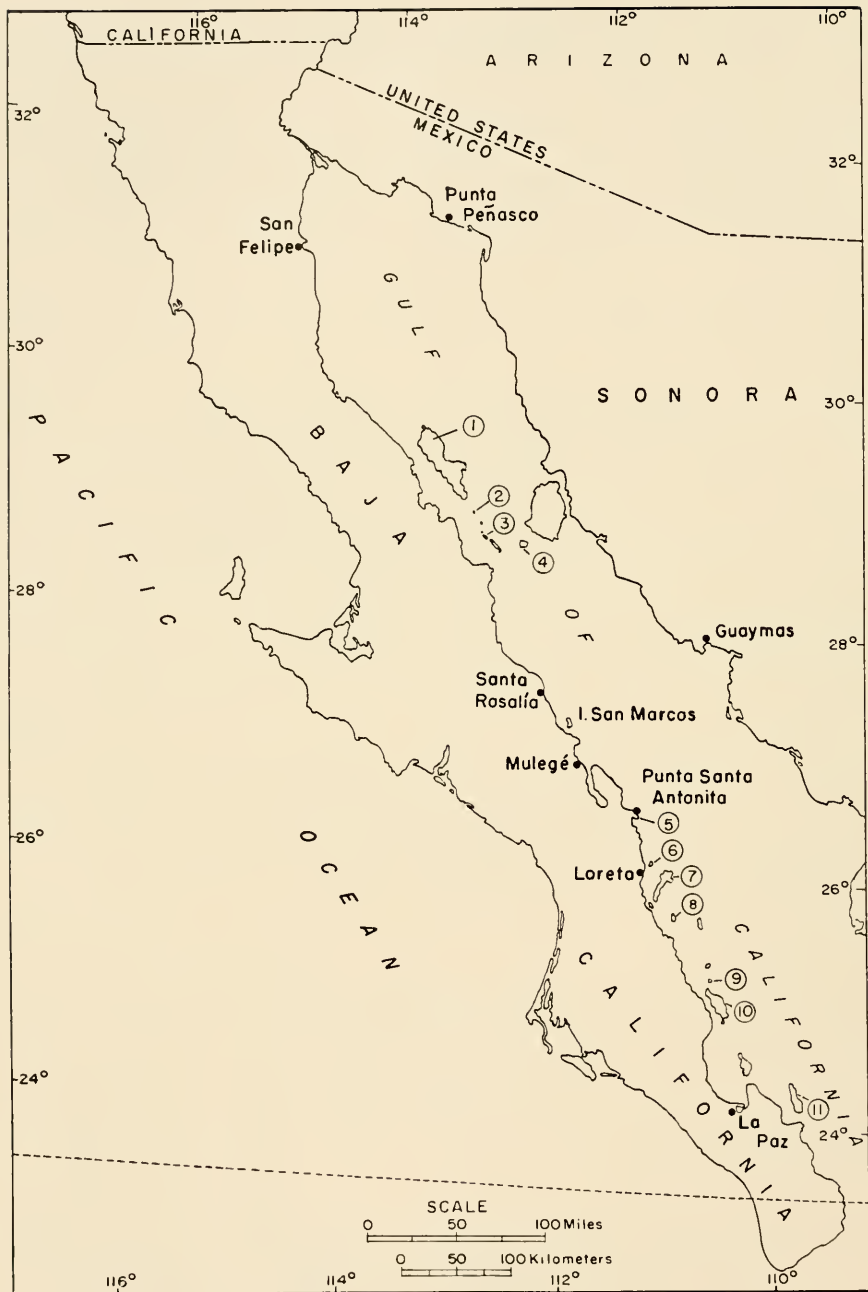


Fig. 1. Map showing the areas from which invertebrate megafossils were collected by the Belvedere Expedition.

Localities indicated by numbered circles are as follows: 1, Isla Angel de la Guarda; 2, Isla Partida; 3, Isla Salsipuedes; 4, Isla San Esteban; 5, El Púlpito; 6, Isla Coronados; 7, Isla Carmen; 8, Isla Monserrate; 9, Isla San Diego; 10, Isla San José; 11, Isla Cerralvo.

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CONTENTS

Introduction	335
Descriptions of Collecting Localities, Faunal Lists, and Age Determinations.....	336
List of Species by Taxonomic Groups, with Age and Collecting Localities.....	348
Systematic Treatment	352
Literature Cited	367

INTRODUCTION

This paper records the fossil invertebrates, mostly mollusks, echinoids and corals, collected by members of the scientific party during the course of the expedition. Fossils ranging in age from early Pliocene to late Pleistocene were obtained from localities on ten islands in the Gulf of California and at El Pulpito on the peninsula of Baja California. Some of the localities were previously unknown, and the collections include guide fossils that have aided in the determination of more precise ages for several poorly known deposits. As a result of our taxonomic studies of the collections, we have proposed herein two new subgeneric names, *Beehtelia*, in the gastropod family Bursidae, and *Morunella*, in the gastropod family Thaididae. We also have described a new species of gastropod, *Cancellaria (Aphera) wigginsii*, from Pleistocene deposits on Isla Monserrate.

Most of the fossils were collected by the senior author, who divided his field work between the Recent and fossil invertebrates, and by Ira L. Wiggins, who collected fossils incidental to his botanical studies. Other members of the scientific party, including Richard C. Banks, Charles F. Harbison, George E. Lindsay, Reid Moran, Charles E. Shaw, and Michael Soulé, also assisted in the collection of fossils when time permitted.

The expedition, sponsored by the San Diego Natural History Museum and the Belvedere Scientific Fund, started from Bahía de los Angeles, Baja California, on March 15, 1962, and terminated at La Paz, Baja California, on April 21, 1962. A general account and log of the expedition, including charts showing the route and anchorage stops of the expedition's ship, M/V "San Agustin II", was published by Lindsay (1962). A report on the terrestrial mollusks obtained by the expedition has been published (Emerson and Jacobson, 1964).

Apparently the first geologist to record the presence of fossil invertebrates in the area of the Gulf of California was the German scientist Grewingk (1848), who described the geology of parts of this region. Although a considerable number of studies on the geology of this area have appeared subsequently, our understanding of the general stratigraphy and knowledge of the Tertiary paleontology of many parts of this region is far from complete. For summaries and bibliographies of the previous reports pertaining to late Cenozoic fossils from the Gulf of California area, the reader is referred to Hanna and Hertlein (1927), Beal (1948; see also Anon., 1924), Durham (1950), and Hertlein (1957). Of particular interest to the

present study are the reports concerning the Pliocene and Pleistocene faunas from the islands in the Gulf and from El Pulpito on the peninsula. Hanna and Hertlein (1927) described the fossil invertebrates collected by the late Dr. Fred Baker on the expedition of the California Academy of Sciences to the Gulf of California in 1921. Durham (1950) authored a report on the megascopic paleontology and marine stratigraphy resulting from a cruise of the schooner "E. W. Scripps" of the Scripps Institution of Oceanography to the Gulf of California in 1940. Hertlein (1957) discussed the Pliocene and Pleistocene fossils collected by Dr. Edwin T. Hammond of the University of California in the region about La Paz in 1949, and those obtained by Dr. G Dallas Hanna and J. R. Slevin of the California Academy of Sciences while on an expedition of the M/V "Orca" to the Gulf of California, including stops at El Mostrador on Isla Cerralvo and at El Pulpito, in 1953. Emerson (1960a) reported Pleistocene invertebrates from Isla Cerralvo obtained by the "Puritan". American Museum of Natural History expedition to western Mexico in 1957.

A number of people have kindly assisted us in the completion of this study. Dr. A. Myra Keen provided us with information on the W. W. Valentine collection of fossils in the Department of Geology of Stanford University. Mr. E. P. Chace of the San Diego Natural History Museum, Mr. and Mrs. John Q. Burch of Los Angeles, California, and Mr. Gordon Ustick of St. Croix, Virgin Islands, provided specimens on loan. Dr. Donald F. Squires of the U. S. National Museum and Dr. J. Wyatt Durham of the University of California Museum of Paleontology examined some of the stony corals in the present collections. Dr. John D. Soule of the Allan Hancock Foundation, University of Southern California, and Mr. Arnold Ross of the Department of Geology of the University of Florida identified the bryozoa and barnacles, respectively. Dr. G Dallas Hanna and Mr. Allyn G. Smith of the California Academy of Sciences, Mrs. Dina Lee Hernandez and Mr. William E. Old, Jr., of the American Museum of Natural History aided us in various ways. The senior author is indebted to Dr. George E. Lindsay for inviting him to join the expedition and to his companions on the trip for their assistance in the field collecting. We are grateful to Mr. K. K. Bechtel and the Belvedere Scientific Fund for making the expedition possible.

The following abbreviations are used to designate institutions listed in this paper: AMNH, American Museum of Natural History, New York, New York; CAS, Department of Geology, California Academy of Sciences, San Francisco, California; SD-BE, San Diego Natural History Museum, Belvedere Expedition, Natural History Museum, San Diego, California; SU, Department of Geology, Stanford University, Stanford, California; UCMP, University of California Museum of Paleontology, Berkeley, California.

DESCRIPTIONS OF COLLECTING LOCALITIES, FAUNAL LISTS, AND AGE DETERMINATIONS

In this section, the localities are briefly described, the faunas are listed using a convenient system of nomenclature that should enable the non-specialist to recognize the taxa without reference to monographic studies, and the age of the deposits is given with as much certainty as our present knowledge permits. Determinations of age assignments for the Pliocene and Pleistocene faunas described in this report generally follow the geochronology that was recognized by Anderson (1950) and Durham (1950) for the marine strata containing metazoan invertebrates on the islands in the Gulf of California. Three divisions were recognized for the Pliocene epoch, namely the Marquer, Carmen and San Marcos formations. These were considered to represent strata deposited during late, middle and early periods of Pliocene time, respectively. Deposits of Pleistocene age were referred to either upper or lower beds. As Durham (*op. cit.*) pointed out, this is a tentative classification that will undoubtedly require refinement as the chronology of these faunas becomes better understood (see fig. 1).

Regional correlations of the Cenozoic formations of the Gulf trough, northern and southern Baja California, and coastal California were presented by Durham and Allison (1960:59-64) in a review of the geology of Baja California. The following correlations were suggested for the Gulf trough sediments of Pliocene age: the Marquer (Anderson, 1950;

Durham, 1950), Inferno (Wilson, 1948, 1955) and Borrego (Tarbet and Holman, 1944) formations, late Pliocene; Carmen (Anderson, 1950; Durham, 1950), Gloria (Wilson, 1948, 1955), and Palm Spring formations, mid-Pliocene; and Imperial (Hanna, 1926), San Marcos (Anderson, 1950; Durham, 1950), and Boleo (Wilson, 1948, 1955) formations, early Pliocene. The Santa Rosalia formation (Wilson, 1948, 1955) was applied to Pleistocene sediments overlying the Inferno formation in the vicinity of Santa Rosalía, Baja California.

Collections from localities F-1 to F-14 are deposited in the San Diego Natural History Museum (SD-BE) and were made by Lindsay, Moran, Banks, Harbison and Emerson. Collections from localities 38539 to 38562 (CAS) were made by Wiggins and are deposited in the Department of Geology of the California Academy of Sciences.

Locality F-1 (SD-BE), Isla Angel de la Guarda, ?Pliocene

Fossils were collected from exposures in the sea cliff on the southeastern end of Isla Angel de la Guarda, about 2 miles south of Isla Pond, March 17, 1962, by Emerson. Sediments consist of fine, poorly consolidated sands filling a terrace-like depression between a low hill and a higher volcanic flow. The fossiliferous bed is a maximum of 50 feet above the present beach and is locally covered with 1 to 5 feet of volcanic rock and alluvium. Oyster shells are common; other fossils are uncommon.

Chione californiensis Broderip

Chione undatella Sowerby

Chlamys (Argopecten) species indeterminate

Ostrea angelica Rochebrune

Unfortunately, the age of this deposit cannot be determined on the basis of its meager fauna. The two worn, imperfect valves of a species of *Chlamys (Argopecten)* are poorly preserved, and we are uncertain whether the specimens represent the Pliocene species, *C. (A.) abietis* Jordan and Hertlein. The other species are not of temporal significance.

Although the surface truncation of the fossiliferous bed suggests a possible Pleistocene age for the deposit, the absence of coarse sediments and the general geologic setting suggest a Pliocene age. Similar deposits that are exposed in a large coastal arroyo south of this locality were considered by Durham (1950:21) to be correlative with the Marquer formation of late Pliocene age.

Locality F-2 (SD-BE), Isla San Esteban, Pliocene

Fossils were collected from exposures in the sea cliff on the east side of Isla San Esteban, opposite our anchorage, March 22, 1962, by Wiggins and Emerson. The sediments are of coarse, well-cemented sand, with an exposed thickness of approximately 100 feet (base not exposed), and the beds are overlain with 1 to 3 feet of soil; the beds are tilted to the north.

Chlamys abietis Jordan and Hertlein

Ostrea species

Eucidaris thouarsii Valenciennes (spines)

coral

This appears to be the first record of the occurrence of fossiliferous sediments on this island. The presence of *Chlamys (Argopecten) abietis* in the fauna indicates a Pliocene age for this deposit.

Locality F-2a (SD-BE), Isla Salsipuedes, ?Pliocene

Fossils were found as float on the northwest side of Isla Salsipuedes at an elevation of about 100 feet, March 24, 1962, by Moran and Emerson.

Ostrea cf. *O. californica* Marcou

On the afternoon of March 23, Moran discovered, in the course of his botanical collecting, a number of large valves of this fossil oyster. The next morning Moran and the senior author visited the area and found several of the large fossils scattered on the surface of a kitchen midden that was composed largely of Recent mollusks. As the source beds for the



Fig. 2. Above. View of sea cliff, south side of El Pulpito, April 2, 1962. Locality F-4 (SD-BE), ?Pleistocene; fossiliferous sandstone overlies volcanic rocks and is overlain by conglomerates and soil cover.

Below. View of sea cliff at Arroyo de la Aguada, Isla San José, April 11, 1962. Locality F-11 (SD-BE), Pliocene; fossiliferous beds are near top of exposure. Large blocks of fossiliferous sandstone have fallen to the beach (senior author is standing on one). Photographs courtesy of G. E. Lindsay.

fossil oysters could not be located in the vicinity of the midden, we must conclude that the oysters had been transported by Indians or by some other non-geological agent to this site.

It is interesting to note that *Ostrea californica* has been reported previously only from early Pliocene deposits of the Imperial formation of Imperial County, California; see the discussion of this species in the systematic section of this paper.

Localities F-3 (SD-BE) and 38562 (CAS), Isla Partida, ?Pliocene

Fossils were collected from exposures in the cliff on the southwest side of the isthmus, March 26, 1962, by Wiggins and Emerson. The top of the cliff is truncated and is covered with 3 to 4 feet of boulder conglomerate of probable Pleistocene age, with 1 to 2 feet of loose boulders resting on the terrace. The lower bed is composed of 65 to 70 feet of locally fossiliferous mudstone and fine sandstone, with pebbles, that weathers a light gray. It is overlain by the conglomerate and is covered at the base by a cobble beach. The terraced cliff is about 75 feet in total thickness. Casts and molds of *Chlamys* are extremely common, with preserved specimens uncommon. Other fossils are rare.

In the following list, taxa marked ¹ are from locality F-3 (SD-BE); those marked ² are from locality 38562 (CAS) = 38441 (CAS).

Barbatia reeveana form *lasperlensis* Sheldon and Maury²

Chlamys tumbezensis d'Orbigny^{1,2}

Plicatula species indeterminate¹

Balanus species¹

Although none of the faunal elements from this locality is of temporal significance, the geologic setting and the composition of the sediments suggest a probable Pliocene age for the fossiliferous sediments. This collection appears to be the first record of the occurrence of fossils on this island.

Localities F-4 (SD-BE) and 38553 (CAS), El Pulpito, Baja California, ?Pleistocene

Fossils were collected from exposures in the sea cliff, on the south side of El Pulpito, Baja California, April 2, 1962, by Lindsay, Wiggins, and Emerson (fig. 2). The richly fossiliferous bed is 4 to 18 feet thick, is composed of well-cemented sandstone weathering pinkish-gray, and rests on volcanic rocks. Locally the base of the exposure is covered by the cobble beach. The deposit is overlain by 20 to 30 feet of boulder conglomerate with coarse sand, pebbles and rocks, and is capped locally by a thin layer of soil and wind-blown sand. Fossils are well preserved; many clams have paired valves, and complete echinoid tests are common (see Lindsay, 1962:20, fig. 15).

The taxa preceded by an asterisk (*) in the following list were not previously reported from the area of El Pulpito. Taxa marked ¹ are from locality F-4 (SD-BE); those marked ² are from locality 38553 (CAS).

Pecten subnodosus Sowerby¹

Pecten vogdesi Arnold¹

Spondylus princeps Broderip¹

Clypeaster speciosus Verrill¹

Encope californica Verrill^{1,2}

Encope cf. *E. grandis inezana* Durham^{1,2} (extinct)

Encope species indeterminate¹

Euclidaris thoursii Valenciennes (spines)^{1,2}

**Meoma* cf. *M. grandis* Gray²

*bryozoa¹

calcareous algae¹

The age of the fossiliferous deposits in the El Pulpito area has yet to be conclusively demonstrated. Grant and Hertlein (1938:47, 98) inferred a Pliocene age for the fauna from El Pulpito Point (W. W. Valentine, MS) with reference to the occurrence of *Encope micropora* Agassiz and *Clypeaster speciosus* Verrill. Durham (1950:47, 50) subsequently indicated that Valentine's specimen of *Encope* was not referable to *E. micropora*, but suggested that it might be his "*Encope* n. sp. B", which he recorded from the Pleistocene of

Isla Coronados. Unfortunately, the manuscript describing the collection from El Pulpito made by the late W. W. Valentine in 1928 has not been published.

At our request, Dr. A. Myra Keen provided us with a list of fossils in the Valentine collection from El Pulpito (SU locality no. 807). Unfortunately, none of the ten species appears to be of temporal significance, although some of the fossils were not identified to species. However, a large collection of fossils recently was recorded by Hertlein (1957:62-65; CAS localities 34036 and 34164) from deposits in an arroyo about one mile northwest of the coast near El Pulpito. None of the species listed by Hertlein is geochronologically restricted to pre-Pleistocene time, but one subspecies, *Encope grandis inezana* Durham, may be restricted to the Pleistocene, and all the other species but one, *Haliotis fulgens* Philippi, are now living in the Gulf of California.

No species in the present collection from this locality are restricted to strata of known Pliocene age. All the species are extant, with the possible exception of the *Encope* identified as *E. cf. E. grandis inezana* Durham, and are known to occur in the Gulf of California at the present time. Many of the species are known to range from early Pliocene to the Present. The field evidence suggests a possible Pliocene age for the fossiliferous sediments. These sediments are well compacted, the sandstone is well sorted, and the deposit is cemented directly on the uncomformable surface of the underlying volcanic rocks. In most Pleistocene deposits in this region, the sediments are poorly compacted and sorted, and they generally overlie basal conglomerates which are cemented to the surface of the terrace platform. This fossiliferous deposit is covered by 20 to 30 feet of poorly sorted, largely uncompacted sediments that probably are at least in part of Pleistocene age (fig. 2). Additional field work in this area will have to be undertaken before a more precise age for this fauna can be determined.

Locality F-5 (SD-BE), Isla Coronados, Pleistocene

Fossils were collected from exposures in the sea cliff that forms a low terrace about 20 feet above the high tide zone on the southern end of Isla Coronados, April 3, 1962, by Emerson. Sediments are locally very fossiliferous, and are composed of coarse, poorly sorted sand that is in places cemented with calcareous algae. Heads of the coral *Porites* are common. The taxa in the following list that are preceded by an asterisk (*) were not previously reported from this locality.

- | | |
|---|--|
| <i>Anadara multicostata</i> Sowerby | * <i>Semele verrucosa</i> Mörch |
| * <i>Anomalocardia subimbricata</i> turmensis Verrill | * <i>Spondylus calcifer</i> Carpenter |
| * <i>Apolymetis cognata clarki</i> Durham | <i>Spondylus princeps</i> Broderip |
| <i>Barbatia reeveana</i> d'Orbigny | <i>Tellina cumingii</i> Hanley |
| <i>Cardita megastrophia</i> Gray | <i>Tellina viridotincta</i> Carpenter |
| <i>Cardium consors</i> Sowerby | <i>Acanthina muricata</i> Broderip |
| <i>Cardium biangulatum</i> Broderip and Sowerby | <i>Aletes centiquadrus</i> Valenciennes |
| <i>Cardium clenense</i> Sowerby | <i>Bulla cf. B. punctulata</i> A. Adams (fragment) |
| <i>Chama frondosa</i> Broderip | <i>Bursa californica</i> Hinds |
| * <i>Chione californiensis</i> Broderip | <i>Cancellaria obesa coronadoensis</i> Durham |
| <i>Codakia distinguenda</i> Tryon | (extinct) |
| * <i>Ctena mexicana</i> Dall | * <i>Cancellaria pulchra</i> Sowerby |
| <i>Diplodonta subquadrata</i> Carpenter | <i>Cantharus anomalus</i> Reeve |
| * <i>Glycymeris gigantea</i> Reeve | <i>Cerithium gemmatum</i> Hinds |
| <i>Glycymeris multicostata</i> Sowerby | <i>Cerithium maculosum</i> Kiener |
| * <i>Isognomon janus</i> Carpenter | * <i>Cerithium sculptum</i> Sowerby |
| <i>Lima tetrica</i> Gould | * <i>Conus diadema</i> Sowerby |
| <i>Lucina lampra</i> Dall | * <i>Conus gladiator</i> Broderip |
| <i>Lucina nuttalli</i> Conrad | <i>Conus princeps</i> Linné |
| <i>Megapitaria squalida</i> Sowerby | <i>Conus purpurascens</i> Broderip |
| <i>Miltha xantusi</i> Dall | <i>Conus regularis</i> Sowerby |
| * <i>Ostrea megodon</i> Hanley | <i>Conus scalaris</i> Valenciennes |
| * <i>Ostrea palmula</i> Carpenter | <i>Conus ximenes</i> Gray |
| <i>Pecten subnodosus</i> Sowerby | * <i>Crepidula arenata</i> Broderip |
| <i>Pecten vogdesi</i> Arnold | <i>Crepidula onyx</i> Sowerby |
| <i>Petricola robusta</i> Sowerby | <i>Cypraea annettae</i> Dall |
| <i>Pinctada mazatlanica</i> Hanley | * <i>Cypraea arabica</i> Lamarck |
| * <i>Semele cf. S. flavescens</i> Gould (juvenile) | <i>Cypraeacassis coarctata</i> Sowerby |

Diodora inaequalis Sowerby
 **Enaeta cumingii* form *pedersenii* Verrill
 **Fasciolaria princeps* Sowerby
Fusinus cinereus Reeve
Gyrineum strongi Jordan (extinct)
 **Hipponix antiquatus* Linné
Knefastia funiculata Kiener
Modulus cerodes A. Adams
Morula lugubris C. B. Adams
 **Murex* cf. *M. elenensis* Dall (fragment)
 **Nassarius tiarula* Kiener
 **Oliva porphyria* Linné
Olivella dama Wood
Olivella species indeterminate (2 fragments)
Parametaria dupontii Kiener

Polinices bifasciata Gray
 **Polinices uber* Valenciennes
Strombus granulatus Swainson, including
 form *cortezianus* Durham
Tegula mariana Dall
 **Terebra* cf. *T. specillata* Hinds
Terebra variegata Gray
 **Trivia californica* Gray
Trivia solandri Sowerby
Turbo fluctuosus Wood
Turbo squamiger Reeve
 **Turritella gonostoma* Valenciennes
Encope californica Verrill
Porites californica Verrill
 crab claw
 calcareous algae

The fauna of these extremely fossiliferous terrace deposits was enumerated by Durham (1950: tables 2 and 3, localities UCMP A-3548 and A-3550). The field evidence and the composition of the fauna suggest that these deposits are late Pleistocene in age.

Localities F-6a, b (SD-BE) and 38539, 38540 (CAS), Puerto Ballandra,
 Isla Carmen, Pliocene

Fossils were collected from a bioherm and sediments at the base of the bioherm that outcrop in the sea cliff on the southeast shore of the bay, April 4, 1962, by Wiggins and Emerson. The cliff is 20 to 25 feet in elevation, with its surface truncated by terraces and with 1 to 2 feet of soil cover. The reef is largely composed of branching heads of *Porites californica* (see Lindsay, 1962, figs. 16, 17), mollusks, echinoid spines, and coarse sand. Sediments of the basal bed are composed of fine sand (mudstone), with well-preserved pelicyclopods common and poorly preserved gastropods uncommon. These deposits abut against volcanic rocks that are exposed in an arroyo and on the adjacent beach.

Coral reef facies [localities F-6a (SD-BE) and 38539 (CAS)]. Fossils are locally common in coarse sand. The taxa preceded by an asterisk (*) in the following lists were not previously reported from this locality. Taxa marked ¹ are from locality F-6a (SD-BE); those marked ² are from locality 38539 (CAS).

Anadara multicosata Sowerby²
 **Anomalocardia subimbricata tumens* Verrill^{1, 2}
Apolymetis cognata clarki Durham²
Barbatia reeveana d'Orbigny^{1, 2}
 **Basterotia hertleini* Durham¹ (extinct)
Cardita affinis californica Deshayes¹
 **Cardita megastropa* Gray¹
Cardium biangulatum Broderip and Sowerby²
Cardium elenense Sowerby^{1, 2}
Chione californiensis Broderip^{1, 2}
Codakia distinguenda Tryon^{1, 2}
 **Corbula bicarinata* Sowerby¹
Ctena mexicana Dall^{1, 2}
Divaricella eburnea Reeve¹
Glycymeris gigantea Reeve^{1, 2}
Glycymeris multicosata Sowerby^{1, 2}
Isognomon janus Carpenter^{1, 2}
Megapitaria squalida Sowerby^{1, 2}
Ostrea angelica Rochebrune^{1, 2}
Pinctada mazatlanica Hanley^{1, 2}
 **Semele* cf. *S. bicolor* C. B. Adams²
Semele flavescens Gould¹
Solecardia eburnea Conrad¹
 **Tellina meropsis* Dall^{1, 2}
 **Tellina viridotincta* Carpenter¹

**Astraca unguis* Wood¹
Cerithium gemmatum Hinds^{1, 2}
Cerithium maculosum Kiener²
 **Conus princeps* Linné¹
 **Crassispira* cf. *C. nymphia* Pilsbry and
 Lowe¹
Crucibulum scutellatum Wood^{1, 2}
Cypraea annettae Dall^{1, 2}
Diodora alta C. B. Adams^{1, 2}
Diodora inaequalis Sowerby^{1, 2}
Fusinus cinereus Reeve¹
Heliculus robertsae Durham¹ (extinct)
 **Hipponix antiquatus* Linné^{1, 2}
 **Modulus cerodes* A. Adams¹
Morula ferruginosa Reeve¹
*Nassarius species*¹ (juvenile)
Oliva spicata (Bolten) Röding¹
Olivella dama Wood^{1, 2}
 **Polinices uber* Valenciennes^{1, 2}
 **Strombus galeatus* Swainson^{1, 2}
Strombus granulatus Swainson^{1, 2}
Tegula mariana Dall^{1, 2}
Turbo fluctuosus Wood^{1, 2}
 calcareous algae^{1, 2}
Porites californica Verrill^{1, 2}
 **Eucidaris thoursii* Valenciennes^{1, 2}

Sand and mudstone facies [locality 6b (SD-BE), marked ¹, and 38540 (CAS), marked ²]. Paired valves of pelecypods common.

Apolymetis cognata clarki Durham¹
Basterotia hertleini Durham^{1, 2} (extinct)
Cardium biangulatum Broderip and Sowerby²
Cardium elenense form *apicinum*
 Carpenter^{1, 2}
 **Chione californiensis* Broderip^{1, 2}
Cyathodonta undulata Conrad^{1, 2}
 **Diplodonta sericata* Reeve^{1, 2}
Divaricella eburnea Reeve^{1, 2}
Lucina lampra Dall^{1, 2}
 **Lucina nuttalli* Conrad²

Megapitaria squalida Sowerby²
Ostrea angelica Rochebrune²
Tagelus politus Carpenter^{1, 2}
Tellidora burneti Broderip and Sowerby¹
 **Tellina amianta* Dall²
 **Tellina reclusa* Dall¹
Tellina simulans C. B. Adams^{1, 2}
 **Nassarius tiarula* Kiener¹
 **Natica unifasciata* Lamarck²
 **Oliva polpasta* Duclos²
 **Olivella dama* Wood¹

These deposits were described and the fossils listed by Durham (1950:39, tables 2, 3, localities UCMP A-3534, reef facies; UCMP A-3670, sand and mudstone facies). Durham (1950:23) considered the deposits referable to the Marquer formation of late Pliocene.

Pleistocene faunas were reported from low terraces at the south end of the bay by Hertlein (1957, CAS locality 34165).

Locality F-7 (SD-BE), Marquer Bay, Isla Carmen, Pliocene

Fossils were collected from exposures in sea cliffs and arroyos adjacent to the beach of the bay on April 4, 1962, by Emerson. The sea cliffs are about 40 feet in elevation, with the surface truncated. The sandstone weathers a light buff and contains well-preserved oysters, pectens and echinoids; other fossils are poorly preserved. Volcanic pebbles and calcareous sand are common.

Anomalocardia subimbricata tumens Verrill
Chione cf. *C. californiensis* Broderip
Chlamys abietis Jordan and Hertlein
Ostrea angelica Rochebrune
Pecten marquerensis Durham
Pecten vogdesi Arnold
Tagelus species indeterminate (mold)
Turritella species indeterminate (mold)
Encope species indeterminate (mold)
Balanus trigonus Darwin

The field evidence and the composition of the fauna suggest that these beds are near the base of the Marquer formation.

Locality 38544 (CAS) [= 38544a], Marquer Bay, Isla Carmen, Pliocene

Fossils were collected by Wiggins from exposures in arroyos about ¼ mile from Marquer Bay, April 5, 1962.

Anadara multicostata Sowerby
Barbatia cf. *B. reeveana* d'Orbigny
Chlamys abietis Jordan and Hertlein
Ostrea angelica Rochebrune
Pecten vogdesi Arnold

The field evidence and the composition of the fauna suggest that this collection was made from beds near the base of the Marquer formation.

Locality 38545 (CAS), Marquer Bay, Isla Carmen, Pliocene

Fossils were collected from exposures in arroyos about ½ mile inland from Marquer Bay, April 5, 1962, by Wiggins.

Chlamys abietis Jordan and Hertlein

Field evidence suggests that this collection was made from beds near the middle of the Marquer formation.

Locality 38546 (CAS) [= 38546a], Marquer Bay, Isla Carmen, Pliocene

Fossils were collected from exposures near the top of a mesa, about 1/2 mile inland from Marquer Bay, April 5, 1962, by Wiggins.

Antigona isocardia Verrill
Barbatia brankampi Durham
Cardium biangulatum Broderip and Sowerby
Chlamys circularis Sowerby
Codakia distinguenda Tryon
Megapitaria squalida Sowerby
Ostrea angelica Rochebrune
Pecten vogdesi Arnold
Spondylus princeps Broderip
Cerithium uncinatum Gmelin

Cypraea annettae Dall
Conus dispar Sowerby
Conus gladiator Broderip
Oliva spicata (Bolten) Röding
Polinices cf. *P. uber* Valenciennes
Strombus galeatus Swainson
Strombus gracilior Sowerby
Strombus granulatus Swainson
Turbo species (operculum)
 coral

The field evidence and the composition of the fauna suggest that this collection was from near the top of the Marquer formation.

Locality F-8 (SD-BE) Isla Monserrate, Pliocene

Fossils were collected from exposures in terraced, light-colored limestone bluffs along the beach near the southwest corner of the island, April 8, 1962, by Emerson. The fossils are poorly preserved, mostly as casts and molds.

Chlamys cf. *C. abietis* Jordan and Hertlein
Pecten cf. *P. stearnsii* Dall

The two species in the present collection indicate a Pliocene age for the deposit. Durham (1950:26) referred similar deposits on the southeastern side of the island to the Carmen formation, which he believed to be mid-Pliocene in age.

Wiggins also collected on April 8, 1962, specimens of a pecten that has been identified as *Chlamys* (*Argopecten*) species indeterminate from deposits of probable Pliocene age on the southwest side of Isla Monserrate (CAS locality 38550).

Localities F-9 (SD-BE) and 38551 (CAS), Isla Monserrate, Pliocene

Fossils were collected from exposures in limestone bluffs that form a small headland north of F-8 (SD-BE), on April 8, 1962, by Wiggins and Emerson. Pectens and oysters are well preserved.

Taxa marked ¹ are from locality F-9 (SD-BE); those marked ² are from locality 38551 (CAS).

Chlamys abietis Jordan and Hertlein^{1, 2}
Ostrea angelica Rochebrune¹
Pecten subnodosus Sowerby¹
Clypeaster species indeterminate² (fragments)

These deposits are correlative with the beds comprising Locality F-8 (SD-BE).

Locality F-9a (SD-BE), Isla Monserrate, ?Pliocene

Fossils were collected from terraces at an elevation of about 600 feet, April 8, 1962, by Moran.

Chlamys aff. *C. abietis* Jordan and Hertlein

The field evidence suggests that the beds at this elevation are Pliocene.

Localities F-10 (SD-BE) and 38554 (CAS), Isla Monserrate, Pleistocene

Fossils were collected from exposures in terrace deposits along the shore on the west side of the island, south of F-9 (SD-BE), April 8, 1962, by Wiggins and Emerson. One to 18 feet of fossiliferous, fine grained sand rests on the terrace platform, which was cut into volcanic rocks a few feet above the present beach.

Taxa marked ¹ are from locality F-10 (SD-BE); those marked ² are from locality 38554 (CAS).

- Anadara multicostata* Sowerby^{1, 2}
Apolymetis cognata clarki Durham^{1, 2}
Barbatia reeveana d'Orbigny²
Cardita megastropha Gray¹
Cardium biangulatum Broderip and Sowerby^{1, 2}
Cardium consors Sowerby^{1, 2}
Cardium elenense Sowerby^{1, 2}
Chione californiensis Broderip^{1, 2}
Codakia distinguenda Tryon¹
Divaricella eburnea Reeve^{1, 2}
Dosinia ponderosa Gray^{1, 2}
Glycymeris gigantea Reeve²
Glycymeris multicostata Sowerby¹
Lucina nuttalli Conrad¹
Lucina lampra Dall^{1, 2}
Megapitaria squalida Sowerby^{1, 2}
Pecten subnodosus Sowerby^{1, 2}
Pecten vogdesi Arnold^{1, 2}
Periglypta multicostata Sowerby¹
Pinctada mazatlanica Hanley¹
Polymesoda species²
Pseudochama saavedraei Hertlein and Strong²
Solecardia eburnea Conrad²
Tagelus californianus Conrad¹
Tellina cumingii Hanley¹
Tellina reclusa Dall¹
Tellina simulans C. B. Adams¹
Astraea unguis Wood²
Calliostoma bonita Strong, Hanna, and Hertlein¹
Calliostoma eximium Reeve²
Cancellaria wigginsii, new species² (extinct)
Cantharus pallidus Broderip and Sowerby²
Cerithium gemmatum Hinds^{1, 2}
Cerithium maculosum Kiener¹
Crucibulum scutellatum Wood¹
Conus brunneus Wood¹
Conus dispar Sowerby²
Conus nux Broderip¹
Conus patricius Hinds¹
Conus perplexus Sowerby¹
Conus princeps Linné¹
Conus purpurascens Broderip^{1, 2}
Conus regularis Sowerby¹
Cypraea annettae Dall¹
Gyrineum strongi Jordan¹ (extinct)
Knefastia fumarula Kiener^{1, 2}
Nassarinus turula Kiener^{1, 2}
Nerita scabricosta Lamarck^{1, 2}
Oliya incrassata Solander^{1, 2}
Oliya spicata (Bolten) Röding^{1, 2}
Olivella dama Wood^{1, 2}
Polinices bifasciata Gray¹
Polinices uber Valenciennes^{1, 2}
Strombina maculosa Sowerby^{1, 2}
Strombus galeatus Swainson^{1, 2}
Strombus gracilior Sowerby^{1, 2}
Strombus granulatus Swainson^{1, 2}
Terebra strigata Sowerby¹
Terebra specillata Hinds¹
Terebra variegata Gray^{1, 2}
Turbo fluctuosus Wood^{1, 2}
Dentalium semipolatum Broderip and Sowerby¹
Pocillopora robusta Verrill¹
Porites species¹
Encope californica Verrill^{1, 2}
Encope grandis Agassiz^{1, 2}
Eucidaris thourasii Valenciennes¹
*calcareous algae*¹

The presence of late Pleistocene fossils in deposits on a 20-foot terrace at the south end of the island was reported by Durham (1950:26, 37, 138), but the fossils, which were said to include only species that are still living, were not listed by him. The present collection was made from deposits that are apparently correlative with those mentioned by Durham (UCMP locality A-3567). The fauna is composed of species that are now living in the Gulf of California, with the exception of *Gyrineum strongi* Jordan and *Cancellaria wigginsii*, new species, both of which are apparently extinct, and *Conus patricius* Hinds.

Locality 38555 (CAS), Isla Monserrate, Pleistocene

Fossils exposed in deposits on the northwest end of the island were collected on April 8, 1962, by Wiggins.

- Basterotia peninsularis* Jordan
Cardium biangulatum Broderip and Sowerby
Cardium elenense Sowerby
Divaricella eburnea Reeve
Lucina lampra Dall
Pitar newcombianus Gabb
Tagelus subteres Conrad
Olivella dama Wood
Polinices uber Valenciennes
Terebra variegata Gray

These deposits may be correlative with those occurring at localities F-10 (SD-BE) and 38554 (CAS). All the species in this collection are modern constituents of the fauna of the Gulf of California except *Basterotia peninsularis* Jordan, which is reported to range from Port Guatulco, Oaxaca, Mexico, south to the Galapagos Islands.

Localities F-11 (SD-BE) and 38549 (CAS), Isla San José, Pliocene

Fossils were collected from exposures on the northeast side of the island along the shore north and south of Arroyo de la Aguada, April 11, 1962, by Wiggins and Emerson. The sea cliffs locally are from 100 to 150 feet in elevation. Their basal part is composed of apparently non-fossiliferous sandstone weathering a buff color, and is overlain by 0 to 25 feet of lighter colored sandstone that is extremely fossiliferous. In the upper beds, pectens, oysters and echinoids are common, but gastropods are preserved only as casts or molds (see fig. 2).

In this area, fossiliferous deposits occur inland at least two miles, as fossils were noted at elevations of more than 500 feet (CAS locality 38548) in beds with an estimated maximum thickness of 40 feet that rest on unfossiliferous sandstones and granite. Although the field evidence suggests that the Pliocene beds have been subsequently truncated by terraces along the adjacent coast and in the arroyo, no Pleistocene fossils were found in the terrace deposits.

Taxa marked ¹ are from locality F-11 (SD-BE); those marked ² are from 38549 (CAS).

Ostrea angelica Rochebrune¹

Ostrea megodon Hanley²

Chlamys abietis Jordan and Hertlein^{1, 2}

Pecten cf. *P. carrizoensis* Arnold¹

Pecten marquerensis Durham^{1, 2}

Pecten subnodosus Sowerby¹

Spondylus cf. *S. princeps* Broderip¹

Comus species indeterminate²

Dendraster casseli Grant and Hertlein¹

Dendraster cf. *D. granti* Durham¹

Balanus tintinnabulum californicus Pilsbry (on pectens)¹

Although Hanna and Hertlein (1927) reported the presence of Pliocene fossils on this island, the fauna remains poorly known. On the basis of the seven species recorded by Hanna and Hertlein (1927:149) and the echinoid cited by Grant and Hertlein (1938:82), a mid-Pliocene age is suggested for at least part of the extensive fossil deposits on the island.

The composition of the present collection, however, suggests that beds representing lower, middle, and upper Pliocene deposits may occur on this island. Valves of a large species of *Pecten* (*sensu stricto*), some 90 mm. high, are not uncommon in these deposits. Unfortunately, only left valves were encountered, and these do not permit a definite identification. These specimens may represent *P. (P.) carrizoensis* Arnold, a species believed to be restricted to the early Pliocene (Durham, 1950:19, 61). The echinoids indicate a mid-Pliocene age (see systematic section of this paper), whereas the presence of *Pecten (Patinopecten) marquerensis* Durham indicates a late Pliocene age (Durham, *op. cit.*:19, 67). Detailed field studies will have to be undertaken before a more precise age can be determined for the strata at this locality.

Localities F-11a (SD-BE) and 38548 (CAS), Isla San José, Pliocene

Fossils were collected from exposures in Arroyo de la Aguada on the northeast side of the island at an elevation of about 530 feet, April 11, 1962, by Banks and Wiggins.

Taxa marked ¹ are from locality F-11a (SD-BE); those marked ² are from locality 38548 (CAS).

Ostrea angelica Rochebrune²

Ostrea megodon Hanley²

Chlamys abietis Jordan and Hertlein^{1, 2}

Chlamys revelli Durham²

Pecten (Patinopecten) cf. *P. (P.) marquerensis* Durham²

Pecten subnodosus Sowerby²

Balanus species¹

The presence of *Chlamys (Argopecten) revelli* Durham suggests a mid-Pliocene age for these deposits. This species was previously known only from the Carmen formation at Salinas Bay, Isla Carmen, and from middle Pliocene deposits on Isla Monserrate (Durham, 1950:19, 64). There is, however, a *Patinopecten* in this collection that is close to *Pecten (Patinopecten) marquerensis* Durham, a species supposedly restricted to the late Pliocene (Durham, 1950:19, 67).

Locality 38547 (CAS), Isla San José, ?Pliocene

Fossils were collected from exposures inland about ¼ mile along the south side of the main arroyo leading eastward from Bahía de Ostiones, on the west side of the island, at an altitude of about 100 feet, on April 12, 1962, by Wiggins.

Anadara cf. *A. multicosata* Sowerby
Ostrea angelica Rochebrune
Pecten species
Placunanomia cumingii Broderip

Although this meager fauna is not geochronologically diagnostic, it should be noted that fossiliferous sediments of Pliocene age were previously known from the west side of the island (Hanna and Hertlein, 1927, CAS locality 839).

Extraordinarily large shell middens of apparent Recent age were reported by Emerson (1960b) from near Amortajada Bay, on the southwestern end of the island.

Locality F-12 (SD-BE), Isla Cerralvo, Pleistocene

Fossils were collected from deposits on a narrow terrace platform that is cut into granitic rocks, at an elevation of 15 to 20 feet, on the west side of the island, April 12, 1962, by Emerson. The terrace deposits are composed of 1 to 4 feet of pebble to boulder conglomerates that are locally fossiliferous. Fossils other than coral fragments and occasional coral heads are uncommon.

Anadara multicosata Sowerby
Pinctada mazatlanica Hanley
Conus purpurascens Broderip
Cerithium maculosum Kiener
Muricanthus princeps Broderip
Strombus galeatus Swainson
Pocillopora robusta Verrill

These terrace deposits are apparently correlative with similar deposits reported by Emerson (1960a) on the south end of the island. All the species in the present collection are living at the present time in the Gulf of California. A late Pleistocene age is indicated for this and other low, emergent, terrace deposits in the Gulf of California region.

Localities F-13 (SD-BE) and 38541, 38542, and 38543 (CAS), Isla Cerralvo, Pliocene

Fossils were collected from exposures along the beach and in arroyos on the west side of the island near El Mostrador, April 16, 1962, by Wiggins and Emerson. The fossiliferous sandstones of the basal beds along the coast weather to a light buff color, carry fragments of calcareous algae, echinoid spines and mollusks, are 10 to 20 feet in thickness, are tilted, warped and faulted, and locally rest on conglomerates and mudstones. The overlying sandstones and conglomerates are locally extremely fossiliferous, with pectens and echinoids common. Other fossils, especially the gastropods, are badly leached. These beds are at least 60 feet thick along the coast and exposures of 100 to 150 feet in thickness were noted in the arroyos. The upper fossiliferous sandstones weather dark buff to gray and are well compacted and cemented.

The taxa in the following list that are preceded by an asterisk (*) were not previously known from this locality. The mark ¹ indicates taxa from locality F-13 (SD-BE), ² indicates 38541 (CAS), ³ indicates 38542 (CAS), and ⁴ indicates locality 38543 (CAS).

**Ostrea* aff. *O. heermanni* Conrad^{1, 2}
Chlamys abietis Jordan and Hertlein^{1, 3, 4}
Chlamys revillei Durham⁴
Pecten subnodosus Sowerby^{1, 4}
Spondylus cf. *S. princeps* Broderip^{1, 4}
Clypeaster bowersi Weaver^{1, 4}
Clypeaster cf. *C. speciosus* Verrill⁴

Balanus tintinnabulum californicus Pilsbry¹
 (on pectens)
Balanus trigonus Darwin¹ (on pectens)
 *colonial stony coral of undetermined generic affinity¹ (internal molds)
 **Conopeum commensale* Kirkpatrick and Metzelaar¹
 *calcareous algae¹

The occurrence of Pliocene faunas in deposits near El Mostrador was previously noted by Hanna and Hertlein (1927) and Hertlein (1957) at CAS localities 840 and 34033, respectively. In addition to the field evidence, the Pliocene age assignment of these deposits was based largely on the presence in one of the collections (Hertlein, 1957) of *Chlamys (Argopecten) abietis* Jordan and Hertlein, a Pliocene species that is not known to occur in beds younger than late Pliocene (Durham, 1950). Only seven other species of megafossils were previously reported from this area. Of these, all are species comprising the modern Panamic fauna, and all but one also occur in the Pleistocene fauna of the lowest emergent terrace of Isla Cerralvo (Emerson, 1960a).

Although the present collection is also small in number of species, the presence of the echinoid, *Clypeaster bowersi* Weaver, suggests an early- or mid-Pliocene age for these deposits. This echinoid is known to occur in strata of early Pliocene age of the Imperial and the San Marcos formations as well as in beds of apparently mid-Pliocene age at Santa Antonita Point, Baja California (Durham, 1950:41). *Ostrea heermanni* Conrad also is known from lower and middle Pliocene deposits (see systematic section of this report). *Chlamys (Argopecten) revellei* Durham, however, was previously known only from beds of mid-Pliocene age of the Carmen formation at Salinas Bay, Isla Carmen, and beds of probable mid-Pliocene age at Isla Monserrate (Durham, 1950:64), and its presence in the collection suggests a mid-Pliocene age for these deposits.

Dr. D. F. Squires considered the internal molds of the colonial coral in the present collection to represent the genus *Solenastrea*, species indeterminate, but Dr. J. Wyatt Durham questioned that assignment. The occurrence of a hermatypic coral of the genus *Solenastrea* in these deposits would be paleogeographically significant. At the present time, *Solenastrea fairbanksi* Vaughan is known in the west Americas only from the early Pliocene beds of the Imperial formation of California and from beds believed to be mid-Pliocene in age on María Madre Island of the Tres Mariás Islands, off the west Mexican state of Nayarit (Durham, 1950). Representatives of the genus *Solenastrea* are known elsewhere from the Oligocene and Miocene of Europe and Asia Minor and from the Miocene to the present time in the West Indies and Florida (Hertlein and Emerson, 1959; Squires, 1959). It should be noted that Durham and Barnard (1952) described a Recent species of *Solenastrea*, *S. ecuadoriana*, on the basis of a single beach-worn specimen thought to have been collected on the shore at La Plata Island, Ecuador. Other species of coral having West Indian affinities may be living at present in the southern part of the Panamic faunal province. As pointed out by Squires (1959), the coral fauna of that zoogeographically critical area is still poorly known.

Locality F-13a (SD-BE), Isla Cerralvo, Pliocene

Fossils were collected from float found along the north side of the arroyo near the site of the old Ruffo Ranch on the west side of the island, April 16, 1962, by Emerson. Fossiliferous sediments were noted for a distance of about a quarter of a mile inland from the mouth of the arroyo. The folded and faulted Pliocene deposits here appear to be several hundred feet thick, and the fossils are embedded in an extremely hard matrix. See remarks for the previous locality.

Chlamys abietis Jordan and Hertlein

Pecten vogdesi Arnold

Locality F-14 (SD-BE), Isla San Diego, Pleistocene

Fossils were collected from isolated deposits on the platform of a small terrace on the southwestern end of this granitic island, on April 19, 1962, by Soulé. The truncated face of the terrace forms a cliff, 12 to 22 feet in elevation, above a cobble beach. The fossils are exposed in coarse sands and conglomerates that rest on the platform about 6 feet above sea level, and the fossiliferous sediments are overlain by 1 to 12 feet of unfossiliferous talus that is composed largely of granitic boulders. Heads of the coral, *Porites*, some of which are six inches in diameter, were found attached to boulders in the basal conglomerates, which are locally preserved in the sea cliff.

Cardita megastropa Gray
Chama buddiana Adams
Chione californiensis Broderip
Chione picta Willett
Chione undatella Sowerby
Codakia distinguenda Tryon
Glycymeris multicostata Sowerby
Pinctada mazatlanica Hanley
Spondylus princeps Broderip
Astraea unguis Wood
Cerithium maculosum Kiener
Conus perplexus Sowerby
Cypraea annettae Dall

Cypraea albuginosa Gray
Diodora inaequalis Sowerby
Gyrineum strongi Jordan (extinct)
Oliva spicata (Bolten) Röding
Parametaria dupontii Kiener
Strombus granulatus Swainson
Turbo fluctuosus Wood
Echinometra vanbrunti Agassiz
Pocillopora robusta Verrill
Porites californica Verrill (heads and fragments)
 calcareous algae (large clumps and fragments)

Squires (1959:424) mentioned this locality in a report on the stony corals collected by the "Puritan"-American Museum of Natural History Expedition to western Mexico in 1957. The fossils, other than *Porites californica*, were not listed.

This terrace is typical of the low emergent terraces throughout the Gulf of California which represent an apparent higher sea level of 12 to 30 feet. Such terraces are known from near the head of the Gulf (Hertlein and Emerson, 1956) to the Cape region of the peninsula (Hertlein, 1957). A late Pleistocene age is suggested for the faunas from these terrace deposits based upon the physiographic and faunal evidence (Emerson, 1960a:4).

LIST OF SPECIES BY TAXONOMIC GROUPS, WITH AGE AND COLLECTING LOCALITIES

The available data do not permit definite age assignments for the faunas from the following localities: SD-BE F-1, F-2a, F-3, F-4, and F-9a; CAS 38547, 38550, 38553, and 38562. See the locality descriptions in the previous section of this paper. Extinct Pleistocene species are noted.

MOLLUSCA PELECYPODA

- Anadara multicostata* Sowerby, Pliocene: Isla Carmen (CAS 38539 and 38544). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10, CAS 38554); Isla Cerralvo (SD-BE F-12).
Anadara cf. *A. multicostata* Sowerby, Pliocene: Isla San José (CAS 38547).
Anomalocardia subimbricata tumens Verrill, Pliocene: Isla Carmen (SD-BE F-6a and F-7, CAS 38539). Pleistocene: Isla Coronados (SD-BE F-5).
Antigona isocardia Verrill, Pliocene: Isla Carmen (CAS 38546).
Apolymetis cognata clarki Durham, Pliocene: Isla Carmen (SD-BE F-6b, CAS 38539). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10, CAS 38554).
Barbatia bramkampii Durham, Pliocene: Isla Carmen (CAS 38546).
Barbatia reeveana d'Orbigny, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (CAS 38554).
Barbatia cf. *B. reeveana* d'Orbigny, Pliocene: Isla Carmen (CAS 38544).
Barbatia reeveana form *lasperlensis* Sheldon and Maury, Pliocene: Isla Partida (CAS 38562).
Basterotia bertleini Durham (extinct), Pliocene: Isla Carmen (SD-BE F-6a and F-6b, CAS 38540).
Basterotia peninsularis Jordan, Pleistocene: Isla Monserrate (CAS 38555).
Cardita affinis californica Deshayes, Pliocene: Isla Carmen (SD-BE F-6a).
Cardita megastropa Gray, Pliocene: Isla Carmen (SD-BE F-6a). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10); Isla San Diego (SD-BE F-14).
Cardium biangulatum Broderip and Sowerby, Pliocene: Isla Carmen (CAS 38539, 38540, and 38546). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10, CAS 38554 and 38555).
Cardium consors Sowerby, Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10, CAS 38554).
Cardium elenense Sowerby, Pliocene: Isla Carmen, (SD-BE F-6a, CAS 38539). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10, CAS 38554 and 38555).
Cardium elenense form *apicinum* Carpenter, Pliocene: Isla Carmen (SD-BE F-6b, CAS 38540).
Chama buddiana Adams, Pleistocene: Isla San Diego (SD-BE F-14).
Chama frondosa Broderip, Pleistocene: Isla Coronados (SD-BE F-5).
Chione californiensis Broderip, Pliocene: Isla Angel de la Guarda (SD-BE F-1); Isla Carmen (SD-BE F-6a and F-6b, CAS 38539 and 38540). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10, CAS 38554); Isla San Diego (SD-BE F-14).
Chione cf. *C. californiensis* Broderip, Pliocene: Isla Carmen (SD-BE F-7).
Chione picta Willett, Pleistocene: Isla San Diego (SD-BE F-14).
Chione undatella Sowerby, Pliocene: Isla Angel de la Guarda (SD-BE F-1). Pleistocene: Isla San Diego (SD-BE F-14).

- Chlamys (Argopecten)* species indeterminate, Pliocene: Isla Angel de la Guarda (SD-BE F-1); Isla Monserrate (CAS 38550).
- Chlamys abietis* Jordan and Hertlein, Pliocene: Isla San Esteban (SD-BE F-2); Isla Carmen (SD-BE F-7, CAS 38544 and 38545); Isla Monserrate (SD-BE F-9, CAS 38551); Isla San José (SD-BE F-11 and F-11a, CAS 38548 and 38549); Isla Cerralvo (SD-BE F-13 and F-13a, CAS 38542 and 38543).
- Chlamys* cf. *C. abietis* Jordan and Hertlein, Pliocene: Isla Monserrate (SD-BE F-8).
- Chlamys* aff. *C. abietis* Jordan and Hertlein, Pliocene: Isla Monserrate (SD-BE F-9a).
- Chlamys circularis* Sowerby, Pliocene: Isla Carmen (CAS 38546).
- Chlamys revellei* Durham, Pliocene: Isla San José (CAS 38548); Isla Cerralvo (CAS 38543).
- Chlamys tumbezensis* d'Orbigny, Pliocene: Isla Partida (SD-BE F-3, CAS 38562).
- Codakia distinguenda* Tryon, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539 and 38546). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10); Isla San Diego (SD-BE F-14).
- Corbula bicarinata* Sowerby, Pliocene: Isla Carmen (SD-BE F-6a).
- Ctena mexicana* Dall, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539). Pleistocene: Isla Coronados (SD-BE F-5).
- Cyathodonta undulata* Conrad, Pliocene: Isla Carmen (SD-BE F-6b, CAS 38540).
- Diplodonta sericata* Reeve, Pliocene: Isla Carmen (SD-BE F-6b, CAS 38540).
- Diplodonta subquadrata* Carpenter, Pleistocene: Isla Coronados (SD-BE F-5).
- Divaricella eburnea* Reeve, Pliocene: Isla Carmen (SD-BE F-6a and F-6b, CAS 38540). Pleistocene: Isla Monserrate (SD-BE F-10, CAS 38554 and 38555).
- Dosinia ponderosa* Gray, Pleistocene: Isla Monserrate (SD-BE F-10, CAS 38554).
- Glycymeris gigantea* Reeve, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (CAS 38554).
- Glycymeris multicostata* Sowerby, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10); Isla San Diego (SD-BE F-14).
- Isoognomon janus* Carpenter, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539). Pleistocene: Isla Coronados (SD-BE F-5).
- Lima tetrica* Gould, Pleistocene: Isla Coronados (SD-BE F-5).
- Lucina lampra* Dall, Pliocene: Isla Carmen (SD-BE F-6b, CAS 38540). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10, CAS 38554 and 38555).
- Lucina nuttalli* Conrad, Pliocene: Isla Carmen (CAS 38540). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10).
- Megapitaria squalida* Sowerby, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539, 38540, and 38546). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10, CAS 38554).
- Miltha xantusi* Dall, Pleistocene: Isla Coronados (SD-BE F-5).
- Ostrea angelica* Rochebrune, Pliocene: Isla Angel de la Guarda (SD-BE F-1); Isla Carmen (SD-BE F-6a and F-7, CAS 38539, 38540, 38544, and 38546); Isla Monserrate (SD-BE F-9); Isla San José (SD-BE F-11, CAS 38548); Isla San José (CAS 38547).
- Ostrea* cf. *O. californica* Marcou, Pliocene: Isla Salsipuedes (SD-BE F-2a).
- Ostrea* aff. *O. heermanni* Conrad, Pliocene: Isla Cerralvo (SD-BE F-13, CAS 38541).
- Ostrea megodon* Hanley, Pliocene: Isla San José (CAS 38548 and 38549). Pleistocene: Isla Coronados (SD-BE F-5).
- Ostrea palmula* Carpenter, Pleistocene: Isla Coronados (SD-BE F-5).
- Ostrea* sp., Pliocene: Isla San Esteban (SD-BE F-2).
- Pecten* cf. *P. carriquensis* Arnold, Pliocene: Isla San José (SD-BE F-11).
- Pecten marquerensis* Durham, Pliocene: Isla Carmen (SD-BE F-7); Isla San José (SD-BE F-11, CAS 38549).
- Pecten (Patinopecten)* cf. *P. (P.) marquerensis* Durham, Pliocene: Isla San José (CAS 38548).
- Pecten* cf. *P. stearnsii* Dall, Pliocene: Isla Monserrate (SD-BE F-8).
- Pecten subnodosus* Sowerby, Pliocene: Isla Monserrate (SD-BE F-9); Isla San José (SD-BE F-11, CAS 38548); Isla Cerralvo (SD-BE F-13, CAS 38543). Pleistocene: El Pulpito (SD-BE F-4); Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10, CAS 38554).
- Pecten vogdesi* Arnold, Pliocene: Isla Carmen (SD-BE F-7, CAS 38544 and 38546); Isla Cerralvo (SD-BE F-13a). Pleistocene: El Pulpito (SD-BE F-4); Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10, CAS 38554).
- Pecten* sp., Pliocene: Isla San José (CAS 38547).
- Periglypta multicostata* Sowerby, Pleistocene: Isla Monserrate (SD-BE F-10).
- Petricola robusta* Sowerby, Pleistocene: Isla Coronados (SD-BE F-5).
- Pinetada mazatlanica* Hanley, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10); Isla Cerralvo (SD-BE F-12); Isla San Diego (SD-BE F-14).
- Pitar newcombianus* Gabb, Pleistocene: Isla Monserrate (CAS 38555).
- Placunanomia cumingii* Broderip, Pliocene: Isla San José (CAS 38547).
- Plicatula* sp., Pliocene: Isla Partida (SD-BE F-3).
- Polymesoda* sp., Pleistocene: Isla Monserrate (CAS 38554).
- Pseudochama saavedrai* Hertlein and Strong, Pleistocene: Isla Monserrate (CAS 38554).

- Semele* cf. *S. bicolor* C. B. Adams, Pliocene: Isla Carmen (CAS 38539).
Semele flavescens Gould, Pliocene: Isla Carmen (SD-BE F-6a).
Semele cf. *S. flavescens* Gould (juvenile), Pleistocene: Isla Coronados (SD-BE F-5).
Semele verrucosa Mörch, Pleistocene: Isla Coronados (SD-BE F-5).
Solecardia eburnea Conrad, Pliocene: Isla Carmen (SD-BE F-6a). Pleistocene: Isla Monserrate (CAS 38554).
Spondylus calcifer Carpenter, Pleistocene: Isla Coronados (SD-BE F-5).
Spondylus princeps Broderip, Pliocene: Isla Carmen (CAS 38546). Pleistocene: El Pulpito (SD-BE F-4); Isla Coronados (SD-BE F-5); Isla San Diego (SD-BE F-14).
Spondylus cf. *S. princeps* Broderip, Pliocene: Isla San José (SD-BE F-11); Isla Cerralvo (SD-BE F-13, CAS 38543).
Tagelus californianus Conrad, Pleistocene: Isla Monserrate (SD-BE F-10).
Tagelus politus Carpenter, Pliocene: Isla Carmen (SD-BE F-6b, CAS 38540).
Tagelus subteres Conrad, Pleistocene: Isla Monserrate (CAS 38555).
Tagelus sp. (mold), Pliocene: Isla Carmen (SD-BE F-7).
Tellidora burneti Broderip and Sowerby, Pliocene: Isla Carmen (SD-BE F-6b).
Tellina amianta Dall, Pliocene: Isla Carmen (CAS 38540).
Tellina cumingii Hanley, Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10).
Tellina meropsis Dall, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539).
Tellina reclusa Dall, Pliocene: Isla Carmen (SD-BE F-6b). Pleistocene: Isla Monserrate (SD-BE F-10).
Tellina simulans C. B. Adams, Pliocene: Isla Carmen (SD-BE F-6b, CAS 38540). Pleistocene: Isla Monserrate (SD-BE F-10).
Tellina viriditincta Carpenter, Pliocene: Isla Carmen (SD-BE F-6a). Pleistocene: Isla Coronados (SD-BE F-5).

GASTROPODA

- Acanthina muricata* Broderip, Pleistocene: Isla Coronados (SD-BE F-5).
Aletes centiquadrus Valenciennes, Pleistocene: Isla Coronados (SD-BE F-5).
Astraea unguis Wood, Pliocene: Isla Carmen (SD-BE F-6a). Pleistocene: Isla Monserrate (CAS 38554); Isla San Diego (SD-BE F-14).
Bulla cf. *B. punctulata* A. Adams (fragment), Pleistocene: Isla Coronados (SD-BE F-5).
Bursa californica Hinds, Pleistocene: Isla Coronados (SD-BE F-5).
Calliostoma bonita Strong, Hanna and Hertlein, Pleistocene: Isla Monserrate (SD-BE F-10).
Calliostoma eximium Reeve, Pleistocene: Isla Monserrate (CAS 38554).
Cantharus obesa coronadoensis Durham (extinct; type locality), Pleistocene: Isla Coronados (SD-BE F-5).
Cantharus pulchra Sowerby, Pleistocene: Isla Coronados (SD-BE F-5).
Cantharus wigginsii, new species (extinct), Pleistocene: Isla Monserrate (CAS 38554).
Cantharus anomalus Reeve, Pleistocene: Isla Coronados (SD-BE F-5).
Cantharus pallidus Broderip and Sowerby, Pleistocene: Isla Monserrate (CAS 38554).
Cerithium gemmatum Hinds, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10, CAS 38554).
Cerithium maculosum Kiener, Pliocene: Isla Carmen (CAS 38539). Pleistocene: Isla Coronados (SD-BE F-5); Isla San Diego (SD-BE F-14); Isla Monserrate (SD-BE F-10); Isla Cerralvo (SD-BE F-12).
Cerithium sculptum Sowerby, Pleistocene: Isla Coronados (SD-BE F-5).
Cerithium uncinatum Gmelin, Pliocene: Isla Carmen (CAS 38546).
Conus bradmeus Wood, Pleistocene: Isla Monserrate (SD-BE F-10).
Conus diadema Sowerby, Pleistocene: Isla Coronados (SD-BE F-5).
Conus dispar Sowerby, Pliocene: Isla Carmen (CAS 38546). Pleistocene: Isla Monserrate (CAS 38554).
Conus gladiator Broderip, Pliocene: Isla Carmen (CAS 38546). Pleistocene: Isla Coronados (SD-BE F-5).
Conus nux Broderip, Pleistocene: Isla Monserrate (SD-BE F-10).
Conus patricius Hinds, Pleistocene: Isla Monserrate (SD-BE F-10).
Conus perplexus Sowerby, Pleistocene: Isla Monserrate (SD-BE F-10); Isla San Diego (SD-BE F-14).
Conus princeps Linné, Pliocene: Isla Carmen (SD-BE F-6a). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10).
Conus purpurascens Broderip, Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10, CAS 38554); Isla Cerralvo (SD-BE F-12).
Conus regularis Sowerby, Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10).
Conus scalaris Valenciennes, Pleistocene: Isla Coronados (SD-BE F-5).
Conus ximenes Gray, Pleistocene: Isla Coronados (SD-BE F-5).
Conus sp., Pliocene: Isla San José (CAS 38549).
Crassispira cf. *C. nymphia* Pilsbry and Lowe, Pliocene: Isla Carmen (SD-BE F-6a).
Crepidula arenata Broderip, Pleistocene: Isla Coronados (SD-BE F-5).

- Crepidula onyx* Sowerby, Pleistocene: Isla Coronados (SD-BE F-5).
Crucibulum scutellatum Wood, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539). Pleistocene: Isla Monserrate (SD-BE F-10).
Cypraea albuginosa Gray, Pleistocene: Isla San Diego (SD-BE F-14).
Cypraea annettae Dall, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539 and 38546). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10); Isla San Diego (SD-BE F-14).
Cypraea arabicula Lamarck, Pleistocene: Isla Coronados (SD-BE F-5).
Cypraeacassis coarctata Sowerby, Pleistocene: Isla Coronados (SD-BE F-5).
Diodora alta C. B. Adams, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539).
Diodora inaequalis Sowerby, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539). Pleistocene: Isla Coronados (SD-BE F-5); Isla San Diego (SD-BE F-14).
Enaeta cumingii form *pedersenii* Verrill, Pleistocene: Isla Coronados (SD-BE F-5).
Fasciolaria princeps Sowerby, Pleistocene: Isla Coronados (SD-BE F-5).
Fusinus cinereus Reeve, Pliocene: Isla Carmen (SD-BE F-6a). Pleistocene: Isla Coronados (SD-BE F-5).
Gyrineum strongi Jordan (extinct), Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10); Isla San Diego (SD-BE F-14).
Heliacus robertsae Durham (extinct), Pliocene: Isla Carmen (SD-BE F-6a).
Hipponix antiquatus Linné, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539). Pleistocene: Isla Coronados (SD-BE F-5).
Knefastia funiculata Kiener, Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10, CAS 38554).
Modulus cerodes A. Adams, Pliocene: Isla Carmen (SD-BE F-6a). Pleistocene: Isla Coronados (SD-BE F-5).
Morula ferruginosa Reeve, Pliocene: Isla Carmen (SD-BE F-6a).
Morula lugubris C. B. Adams, Pleistocene: Isla Coronados (SD-BE F-5).
Murex cf. *M. elenensis* Dall (fragment), Pleistocene: Isla Coronados (SD-BE F-5).
Muricanthus princeps Broderip, Pleistocene: Isla Cerralvo (SD-BE F-12).
Nassarius tiarula Kiener, Pliocene: Isla Carmen (SD-BE F-6b). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10, CAS 38554).
Nassarius sp. (juvenile), Pliocene: Isla Carmen (SD-BE F-6a).
Natica unifasciata Lamarck, Pliocene: Isla Carmen (CAS 38540).
Nerita scabricosta Lamarck, Pleistocene: Isla Monserrate (SD-BE F-10, CAS 38554).
Oliva incrassata Solander, Pleistocene: Isla Monserrate (SD-BE F-10, CAS 38554).
Oliva polpasta Ducloux, Pliocene: Isla Carmen (CAS 38540).
Oliva porphyria Linné, Pleistocene: Isla Coronados (SD-BE F-5).
Oliva spicata (Bolten) Röding, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38546). Pleistocene: Isla Monserrate (SD-BE F-10, CAS 38554); Isla San Diego (SD-BE F-14).
Olivella dama Wood, Pliocene: Isla Carmen (SD-BE F-6a and F-6b, CAS 38539). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10, CAS 38554 and 38555).
Olivella sp. (2 fragments), Pleistocene: Isla Coronados (SD-BE F-5).
Parametaria dupontii Kiener, Pleistocene: Isla Coronados (SD-BE F-5); Isla San Diego (SD-BE F-14).
Polinices bifasciata Gray, Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10).
Polinices uber Valenciennes, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10, CAS 38554 and 38555).
Polinices cf. *P. uber* Valenciennes, Pliocene: Isla Carmen (CAS 38546).
Strombina maculosa Sowerby, Pleistocene: Isla Monserrate (SD-BE F-10, CAS 38554).
Strombus galeatus Swainson, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539 and 38546). Pleistocene: Isla Monserrate (SD-BE F-10, CAS 38554); Isla Cerralvo (SD-BE F-12).
Strombus gracilior Sowerby, Pliocene: Isla Carmen (CAS 38546). Pleistocene: Isla Monserrate (SD-BE F-10, CAS 38554).
Strombus granulatus Swainson, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539 and 38546). Pleistocene: Isla Monserrate (SD-BE F-10, CAS 38554); Isla San Diego (SD-BE F-14).
Strombus granulatus Swainson, including form *cortezianus* Durham, Pleistocene: Isla Coronados (SD-BE F-5).
Tegula mariana Dall, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539). Pleistocene: Isla Coronados (SD-BE F-5).
Terebra specillata Hinds, Pleistocene: Isla Monserrate (SD-BE F-10).
Terebra cf. *T. specillata* Hinds, Pleistocene: Isla Coronados (SD-BE F-5).
Terebra strigata Sowerby, Pleistocene: Isla Monserrate (SD-BE F-10).
Terebra variegata Gray, Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10, CAS 38554 and 38555).
Trivia californica Gray, Pleistocene: Isla Coronados (SD-BE F-5).
Trivia solandri Sowerby, Pleistocene: Isla Coronados (SD-BE F-5).

- Turbo fluctuosus* Wood, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539). Pleistocene: Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10, CAS 38554); Isla San Diego (SD-BE F-14).
Turbo squamiger Reeve, Pleistocene: Isla Coronados (SD-BE F-5).
Turbo species (operculum), Pliocene: Isla Carmen (CAS 38546).
Turritella gonostoma Valenciennes, Pleistocene: Isla Coronados (SD-BE F-5).
Turritella species indeterminate (mold), Pliocene: Isla Carmen (SD-BE F-7).

SCAPHOPODA

- Dentalium semipolatum* Broderip and Sowerby, Pleistocene: Isla Monserrate (SD-BE F-10).

ECHINODERMATA

ECHINOIDEA

- Clypeaster bowersi* Weaver, Pliocene: Isla Cerralvo (SD-BE F-13, CAS 38543).
Clypeaster speciosus Verrill, Pleistocene: El Pulpito (SD-BE F-4).
Clypeaster cf. *C. speciosus* Verrill, Pliocene: Isla Cerralvo (CAS 38543).
Clypeaster sp. (fragments), Pliocene: Isla Monserrate (CAS 38551).
Dendraster casseli Grant and Hertlein, Pliocene: Isla San José (SD-BE F-11).
Dendraster cf. *D. granti* Durham, Pliocene: Isla San José (SD-BE F-11).
Echinometra yanbrunti Agassiz, Pleistocene: Isla San Diego (SD-BE F-14).
Encope californica Verrill, Pleistocene: El Pulpito (SD-BE F-4, CAS 38553); Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10, CAS 38554).
Encope grandis Agassiz, Pleistocene: Isla Monserrate (SD-BE F-10, CAS 38554).
Encope cf. *E. grandis inezana* Durham, Pleistocene: El Pulpito (SD-BE F-4, CAS 38553).
Encope sp., Pliocene: Isla Carmen (SD-BE F-7). Pleistocene: El Pulpito (SD-BE F-4).
Eucidaris thouarsii Valenciennes, Pliocene: Isla San Esteban (SD-BE F-2); El Pulpito (SD-BE F-4, CAS 38553); Isla Carmen (SD-BE F-6a, CAS 38539). Pleistocene: Isla Monserrate (SD-BE F-10).
Meoma cf. *M. grandis* Gray, Pleistocene: El Pulpito (CAS 38553).

COELENTERATA

SCLERACTINIA

- Colonial stony coral of undetermined generic affinity (internal molds), Pliocene: Isla Cerralvo (SD-BE F-13).
 Coral, Pliocene: Isla San Esteban (SD-BE F-2); Isla Carmen (CAS 38546).
Pocillopora robusta Verrill, Pleistocene: Isla Monserrate (SD-BE F-10); Isla Cerralvo (SD-BE F-12); Isla San Diego (SD-BE F-14).
Porites californica Verrill, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539). Pleistocene: Isla Coronados (SD-BE F-5); Isla San Diego (SD-BE F-14).
Porites species, Pleistocene: Isla Monserrate (SD-BE F-10).

BRYOZOA

ECTOPROCTA

- Bryozoa, Pleistocene: El Pulpito (SD-BE F-4).
Conopeum commensale Kirkpatrick and Metzelaar, Pliocene: Isla Cerralvo (SD-BE F-13).

ARTHROPODA

CRUSTACEA

- Crab claw, Pleistocene: Isla Coronados (SD-BE F-5).

CIRRIPEDIA

- Balanus tintinnabulum californicus* Pilsbry (on pectens), Pliocene: Isla San José (SD-BE F-11); Isla Cerralvo (SD-BE F-13).
Balanus trigonus Darwin, Pliocene: Isla Carmen (SD-BE F-7); Isla Cerralvo (SD-BE F-13).
Balanus sp., Pleistocene: Isla Partida (SD-BE F-3); Isla San José (SD-BE F-11a).

ALGAE

CALCAREOUS ALGAE

- Calcareous algae, Pliocene: Isla Carmen (SD-BE F-6a, CAS 38539); Isla Cerralvo (SD-BE F-13). Pleistocene: El Pulpito (SD-BE F-4); Isla Coronados (SD-BE F-5); Isla Monserrate (SD-BE F-10); Isla San Diego (SD-BE F-14).

SYSTEMATIC TREATMENT

In this section, synonymies and notes are presented for mollusks and echinoids in the present collection that are of particular interest. The synonymies of these species are restricted, with a few exceptions, to records reported from the Gulf trough. The collecting stations for each species are listed in the previous section of this paper. References in the synonymies and the discussions in this section are not repeated in the "Literature Cited" of this report.

A new species of gastropod and two new subgeneric names in the Class Gastropoda are proposed.

Phylum MOLLUSCA
Class PELECYPODA
Family OSTREIDAE

Ostrea angelica Rochebrune, 1895

Figures 3a-c

Ostrea cumingiana "Dunker" [of west American authors]. — Vokes in Wilson, Bull. Amer. Assoc. Petrol. Geol., vol. 32, no. 9, p. 1784, 1948. "Santa Rosalia Formation (Pleistocene)". — Vokes in Wilson, Univ. Nac. Auton. de Mexico, Inst. Geol. Geofis., and Geodesia, Bol. no. 53, p. 41, 1948. Same record as preceding reference. — Vokes in Wilson and Veytia, U. S. Geol. Surv., Bull. 960-F, p. 199, 1949. South side of Arroyo del Infierno, uppermost Pliocene or Pleistocene. Range, uppermost Pliocene to Recent. — Durham, Geol. Soc. America, Mem. 43, pt. 2, p. 58, pl. 5, fig. 6, and probably fig. 7 (as *O. vespertina* Conrad), 1950. Late Pliocene to Recent in the Gulf of California region. — Vokes in Wilson and Rocha, U. S. Geol. Surv., Prof. Paper 273, p. 40, 1955. Same as earlier records by Vokes. — Durham and Hertlein in Arnold, Univ. Calif. Publ. Geogr., vol. 10, no. 4, p. 242, 1957. In small arroyo in the 200(?) foot terrace, near the coast at Santa Rosalillita, Baja California. Probably uppermost Pliocene or lowermost Pleistocene.

Not *Ostrea cumingiana* Dunker, Zeitschr. f. Malakozool., Jahrg. 3, p. 48, 1846. "*Patria ignota.*" [Now believed to be a Japanese species].

Ostrea angelica Rochebrune, Bull. Mus. Nat. d'Hist. Nat. Paris, vol. 1, p. 241, 1895. "Baie de Los Angeles," east coast of Baja California, Recent. — Contreras, An. Inst. Biol. (Mexico), vol. 3, no. 3, p. 207, figs. 18 and 19, 1932. "Bahía de Los Angeles, Golfo de California." — Hertlein and Emerson, Trans. San Diego Soc. Nat. Hist., vol. 12, no. 8, p. 165, 1956. Puerto Peñasco, Sonora, Mexico; Pleistocene. — Hertlein, Bull. South. Calif. Acad. Sci., vol. 56, pt. 2, pp. 59, 63, 1957. Sea cliff about 1/2 mile east of mouth of Arroyo del Coyote, 2 1/2 miles southeast of Punta Coyote, 11 miles northeast of La Paz, Baja California; Pleistocene. Also, Pleistocene elevated beach at Santa Inez Bay, Baja California; and Carmen Island; Pleistocene. Probably also "*Ostrea cf. angelica*" from low hills back of Santa Inez Bay, Baja California; Pleistocene. — Emerson and Chace, Trans. San Diego Soc. Nat. Hist., vol. 12, no. 2, pp. 338, 341, May 27, 1959. Tecolote Creek, San Diego, California; Pleistocene. ?Spanish Bight, San Diego, California; Pleistocene. Punta Peñasco, Sonora, Mexico; Recent. — Hertlein and Emerson, Amer. Mus. Novitates, no. 1940, p. 8, June 5, 1959. María Madre Island, Tres Marias Islands, Mexico; Pliocene. — Emerson, Amer. Mus. Novitates, no. 1995, p. 5, March 29, 1960. "South side of Ceralvo Island," Pleistocene. — Emerson, Amer. Mus. Novitates, no. 2013, p. 6, August 18, 1960. Middens of San José Island, Gulf of California.

[?] *Ostrea cf. angelica* Rochebrune, Vokes in Wilson, Bull. Amer. Assoc. Petrol. Geol., vol. 32, no. 9, pp. 1782 and 1783, 1948. "Gloria Formation (Middle Pliocene)" and "Infierno Formation (Upper Pliocene)". — Vokes in Wilson, Univ. Nac. Auton. Mexico, Inst. Geol. Geofis. y Geodesia, Bol., no. 53, pp. 37, 38, 1948. Same records as in preceding reference. — Vokes in Wilson and Veytia, U. S. Geol. Surv., Bull. 960-F, p. 197, 1949. Same record as Vokes, 1948. — Vokes in Wilson and Rocha, U. S. Geol. Surv., Prof. Paper 273, pp. 36, 39, 1955. Same records as in preceding reference.

Range. — Mid-Pliocene to Recent. Recent from San Ignacio Lagoon to San Felipe, Baja California, and south to Mazatlán, Sinaloa, Mexico.

Remarks. — Many specimens of this species were collected from beds of Pliocene and of Pleistocene age. The valves are identical with Recent specimens living in the same region.

The valves of *Ostrea angelica* are rather thick, strongly plicated, and interlock along the margins. Denticles are present along the margin just below the hinge. The interior of Recent specimens is tinged with green. Large specimens attain a length (beak to base) of 123 mm.

The valves of *Ostrea angelica* are much larger and the area of attachment is larger than that of *O. vespertina* Conrad from the type locality, Imperial County, California (compare figures 3a-c with 3d-h).

Ostrea cf. O. californica Marcou, 1858

The following references are to typical *O. californica*.

Ostrea virginica var. *californica* Marcou, Geol. North America (Zurich), p. 32, pl. 5, figs. 2, 2a, 1858. "In the Colorado desert, California; near Carrizo Creek, between San Diego and Fort Yuma." Miocene or Pliocene.

Ostrea iridescens Gray, G. D. Hanna, Proc. Calif. Acad. Sci., Fourth Ser., vol. 14, no. 18, p. 468, pl. 26, figs. 4, 5, 6, 7, March 23, 1926. Coyote Mountain, Imperial County, California, Pliocene.

Not *Ostrea iridescens* Gray, in Hanley, 1854.

Ostrea californica Marcou, Hanna and Hertlein, Nautilus, vol. 41, no. 2, pp. 45, 46, 1927. Earlier records cited.

Geologic Record. — Previously known only from the Imperial formation.

Remarks.—A large, thick, elongated lower valve of an oyster¹ was collected at Loc. F-2A, on the south slope on the northwest side of Isla Salsipuedes at an altitude of about 100 feet. It is 271 mm. long, 105 mm. wide, and 60 mm. thick. This valve was found with Recent shells in kitchen middens and its original source is unknown.

The shape, ligamental groove and general shell characters of this valve are similar to those of *Ostrea californica* from strata of Pliocene age in Imperial County, California, except that it is much larger and thicker. Likewise, it is much larger and thicker than *O. corteziensis* Hertlein, a species that lives at the present time in the Gulf of California. *Ostrea corteziensis* was cited as a fossil from the Gulf region by Durham (1950:58, pl. 4, fig. 1), as *Ostrea chilensis* Philippi (see Hertlein, L. G., Bull. South. Calif. Acad. Sci., vol. 50, pt. 2, p. 72, 1951).

The general appearance of the exterior of this fossil, except for greater size and thickness, resembles *O. englekeyi* Hertlein, a species described from mid-Miocene strata on Santa Rosa Island, California. The characters of the interior of the type specimen of *O. englekeyi* are not known.

Positive identification of this oyster, based on this somewhat worn valve, is doubtful; certainly it is a fossil form.

Ostrea heermanni Conrad, 1855

Ostrea heermanni Conrad, Proc. Acad. Nat. Sci. Philadelphia, vol. 7, p. 267, February, 1855 [under heading of Miocene Species]. "Colorado Desert. Dr. Heermann. Shell silicified."—Conrad, House Exec. Document 129, 33rd Congress, 1st Session, p. 15, July, 1855. "Locality.—Carrizo creek, Colorado desert. Dr. Heermann."—Conrad, U. S. Pac. Railroad Repts., vol. 5, pt. 2, p. 326, 1857. "Locality.—Carrizo creek, Colorado desert. Dr. Heermann."—Gabb, Geol. Surv. Calif., Palaeo., vol. 2, p. 107, 1869. "Pliocene, Colorado Desert."—Heilprin, U. S. Geol. Surv., Fourth Ann. Rept., p. 314, 1884. Earlier records cited.—Orcutt, West Amer. Sci., vol. 12, no. 1 (102), p. 12, 1901 (as *Ostrea heermanni*). Miocene: Carrizo Creek.—Hanna, Proc. Calif. Acad. Sci., Fourth Ser., vol. 14, no. 18, p. 467, pl. 22, figs. 7, 8; pl. 23, figs. 1, 2, 1926. Loc. 693 (CAS), Yuba Buttes, Imperial County, California; Pliocene.—Woodring, Carnegie Inst. Washington, Publ. no. 418, p. 11, 1931. Painted Hill, Miocene.—Hertlein, Jour. Paleol., vol. 5, no. 4, p. 366, 367, 1931. Float five kilometers north of Santa Rosalia, Baja California; late Pliocene or Pleistocene; Arroyo Cadejé above the Rancho Cadejé, Baja California [Pliocene].—Woodring, U. S. Geol. Surv., Prof. Paper, 190, p. 46, 1938. Imperial formation, Colorado Desert.—Hertlein, Bull. South. Calif. Acad. Sci., vol. 56, pt. 2, p. 58, 1957. Two miles southeast of La Rivera and about one mile from the coast of Baja California; also in arroyo wall 4½ miles northeast of Sierra de la Trinidad, 9 miles southeast of Santiago, Baja California; Pliocene.

Range.—Pliocene; early and mid-Pliocene of Durham (1950).

Remarks.—Several fragments of this large, thick-shelled, rounded oyster, one 126 mm. long, were collected on Isla Cerralvo. These reveal the presence of the large ligamental groove and the rounded, sunken muscle impression, comparable to typical *Ostrea heermanni* from strata of Pliocene age in Imperial County, California, as well as other specimens from southeastern Baja California. The present specimens closely resemble those illustrated by Hanna (1926).

Family PECTINIDAE

Chlamys (Argopecten) abietis (E. K. Jordan and Hertlein, 1926)

Figures 4a-e

Pecten (Plagiocentium) abietis E. K. Jordan and Hertlein, Proc. Calif. Acad. Sci., Fourth Ser., vol. 15, no. 4, p. 214, pl. 23, figs. 1, 3, 7, April 26, 1926. "Arroyo Hondo, Maria Madre Island, Mexico; upper Pliocene."—Touade, Econ. Geol., vol. 25, no. 2, p. 122, 1930. Upper Salada or calcareous series, Santa Rosalia, Baja California; Pliocene, probably upper Pliocene.—Hertlein, Bull. South. Calif. Acad. Sci., vol. 56, pt. 2, p. 60, 1957. "Santa Inez Bay, east coast of Lower California. From hard, brownish, limy, sandy strata in low hills back of the bay which, toward the beach, are overlain by Pleistocene terrace material"; Pliocene.—Foose, Bull. Amer. Assoc. Petrol. Geol., vol. 46, no. 9, p. 1743, 1962. Maria Cleofa Island, Tres Marias Islands, Pliocene.

Aequipecten abietis Jordan and Hertlein, Vokes in Wilson, Bull. Amer. Assoc. Petrol. Geol., vol. 32,

¹Since the present paper was submitted for publication, oysters similar to the present species were collected by Dr. C. C. McFall from strata on the southwest end of Concepcion Peninsula, Concepcion Bay, Baja California. Species of early or middle Pliocene age accompanying the oysters include, *Ostrea heermanni* Conrad, *Chlamys abietis* (Jordan and Hertlein), *Pecten subnodosus* Sowerby, *Cantharus* cf. *C. pallidus* Broderip and Sowerby and *Turritella* cf. *T. imperialis* Hanna.

no. 9, pp. 1780, 1782, 1783, 1948. Gloria formation, middle Pliocene and Inferno formation, upper Pliocene. — Vokes in Wilson, Univ. Nac. Auton. Mexico, Inst. Geol., Geofis. y Geodesia, Bol. no. 53, pp. 37, 39, 1948. Same records as in preceding reference. — Vokes in Wilson and Veytia, U. S. Geol. Surv., Bull. 960-F, pp. 194, 197, 198, 1949. Cited from Lower, middle, and upper Pliocene. — Durham, Geol. Soc. America, Mem. 43, pt. 2, p. 62, pl. 10, figs. 4, 7; pl. 11, fig. 4, August 10, 1950. Various localities cited in Gulf of California region, lower, middle and upper Pliocene. — Vokes in Wilson and Rocha, U. S. Geol. Surv., Prof. Paper 273, pp. 32, 36, 39, 1955. Early, middle and late Pliocene.

Pecten (Argopecten) abietis E. K. Jordan and Hertlein, Hertlein and Emerson, Amer. Mus. Novitates, no. 1940, p. 8, 1959. María Cleofa and María Madre Islands, Tres Marias Islands, Pliocene.

Range. — Pliocene; early to mid-Pliocene of Durham (1950).

Remarks. — This species is one of the most common fossils characteristic of strata of Pliocene age in the Gulf of California region.

The radial ribs on shells of this species, especially in the earlier stage, are triangular to subtriangular and the interspaces are very narrow. A dense fringe of concentric lamellae cover the sides of the ribs and interspaces. These characters serve to separate it from *Chlamys (Argopecten) circularis* (Sowerby), in which the ribs are more rounded and narrower in cross-section, the interspaces are wider, and the concentric lamellae are only weakly developed (see fig. 4a-e).

Chlamys (Pacifipecten) tumbezensis (d'Orbigny, 1835)

Pecten aspersus Sowerby, Proc. Zool. Soc. London for 1835, p. 110, October 9, 1835. "Hab. ad Tumbes, Peruviae. Dredged in soft mud at a depth of five fathoms."

Not *Pecten aspersus* Lamarck, 1819.

Pecten tumbezensis d'Orbigny, Voy. dans l'Amérique Méridionale, vol. 5, p. 663, 1846. Tumbes, Peru. New name for *Pecten aspersus* Sowerby, 1835, not *Pecten aspersus* Sowerby, 1825. — Peile in Bosworth, Geol. northwest Peru, p. 178, pl. 25, fig. 8, 1922. "Talara Tablazo" and "Lobitos Tablazo". Quaternary, Peru. — Olsson, Bull. Amer. Paleol., vol. 27, no. 106, p. 171 (19), 1942. Rio La Vaca, Costa Rica, Pliocene. — Lemon and Churcher, Amer. Jour. Sci., vol. 259, no. 6, p. 415, 1961. Talara Tablazo, Peru, Pleistocene.

Pecten (Leptopecten) tumbezensis d'Orbigny, Hertlein, Proc. Calif. Acad. Sci., Fourth ser., vol. 21, no. 25, p. 314, pl. 19, figs. 11, 12, 1935. Gulf of California to Tumbes and Paita, Peru. Also Quaternary of Peru. [With synonymy]. — Hoffstetter, Bol. Inform. Cienc. Nat., vol. 2, nos. 13-14, p. 73, 1948. Tercer Tablazo [youngest], Santa Elena Peninsula, Ecuador. — Hertlein and Strong, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 180, 1955. Gulf of California and east of San José del Cabo, Baja California to Paita, Peru. [With synonymy]. — Grau, Allan Hancock Pac. Exped., vol. 23, p. 118, pl. 40, 1959. Gulf of California to Paita, Peru. [With synonymy].

Pecten (Plagiopecten) tumbezensis d'Orbigny, Pilsbry and Olsson, Proc. Acad. Nat. Sci. Philadelphia, vol. 93, p. 55, 1941. Canoa formation, Punta Blanca, Ecuador.

Aequipecten (Pacifipecten) tumbezensis d'Orbigny, Olsson, Mollusks of the Tropical Eastern Pacific (Paleo. Res. Inst.: Ithaca, New York), p. 164, pl. 21, figs. 2-2c, 1961. Gulf of California to Paita, Peru.

Range. — Pliocene to Recent. Recent from south of Consag Rock (31° N.), Gulf of California, to Paita, Peru, in 1.8-110 meters (1-61 fathoms).

Remarks. — About 25 valves, in various stages of preservation, were collected in grayish-brown sediment on Isla Partida. Many of these are bent and deformed. This feature, as well as the character of the strata in which the shells occur, leads us to assign questionably a Pliocene age to these fossils.

The shell of this species is rather small, rarely more than 35 mm. high, and comparatively thick for its size. It is sculptured with 13 to 15 radial ribs; those on the right valve are nearly square, whereas those on the left are narrowly triangular and are separated by wider interspaces.

Family SPORTELLIDAE

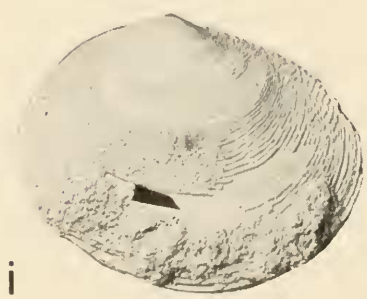
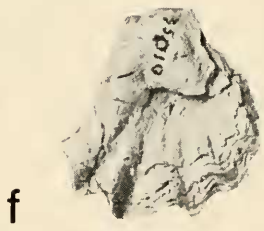
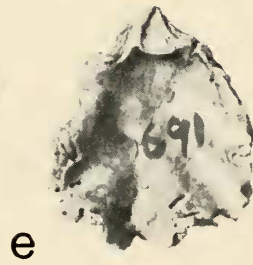
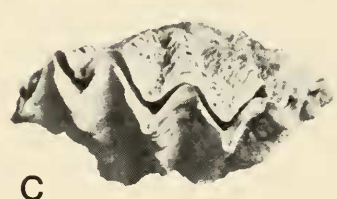
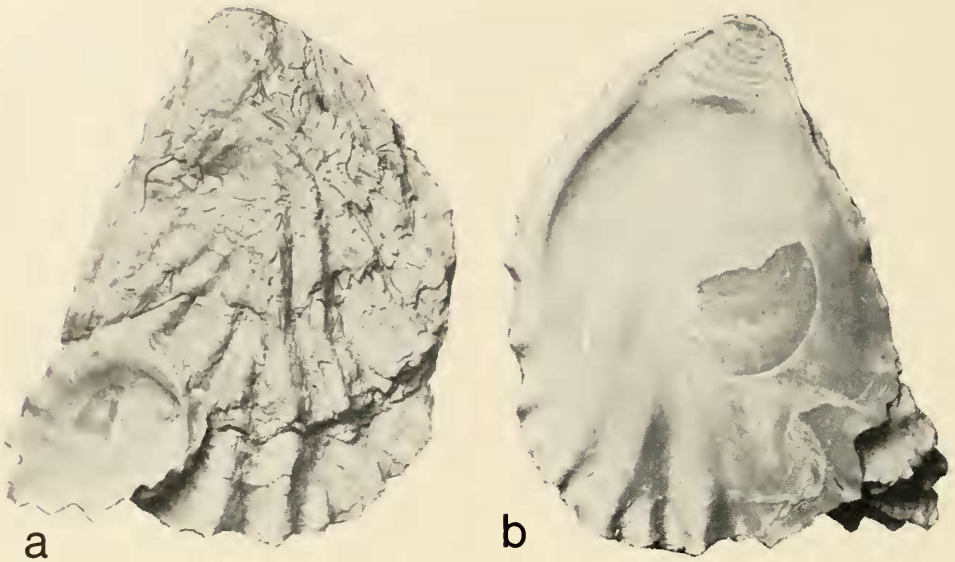
Basterotia (Basterotella) hertleini Durham, 1950

Figures 4g-j

Basterotia hertleini Durham, Geol. Soc. Amer. Mem. 43, pt. 2, pp. 94, 95, pl. 25, figs. 4, 11, August 10, 1950. Puerto Ballandra, Carmen Island (type locality), late Pliocene; Marquer Bay, Carmen Island, late Pliocene.

Range. — Late Pliocene (Marquer formation).

Remarks. — Paired valves of this species were common in the siltstone bed that forms the basal part of the large coral reef of Pliocene age at Puerto Ballandra, Isla Carmen; see photographs in Lindsay (1962: figs. 16, 17). Only one single valve was found in the coarser sediments of the reef.



This species seems to be most closely related to *Basterotia* (*Basterotella*) *ecuadoriana* Olsson, which was described from Recent specimens taken at Manta and Santa Elena, Ecuador. However, the present specimens appear to be smaller and to have finer surface sculpture than those described by Olsson. *Basterotia* (*B.*) *peninsularis* Jordan, known from the Pleistocene of Magdalena Bay, Baja California, and Islas Monserrate and Coronados, and reported to be living at present from Port Guatulco, Oaxaca, Mexico, to the Galapagos Islands, is also a similar species, but has a less elongate and more inflated shell.

Family VENERIDAE

Chione (*Nioche*) *picta* Willett, 1944

[?] *Tapes squamosa* Carpenter, Catalogue of the Collection of Mazatlan Shells, . . . (British Museum: London), p. 78, 1857. "Mazatlan; from washings of Chamae and Spondyli; extremely rare." Recent.

Chione picta Dall, Manger, Johns Hopkins Univ., Stud. Geol., no. 11, p. 289, 1934. San Quintin Bay, Baja California, Mexico. Pleistocene. [*Nomen nudum*]

Chione picta Willett, ex Dall MS., Bull. So. Calif. Acad. Sci., vol. 43, pp. 21, 22, pl. 8, May 31, 1944. Living in Magdalena Bay, Baja California, Mexico (type locality) and at other west Mexican localities, and from Pleistocene deposits in the Los Angeles basin of southern California. — Woodring, U. S. Geol. Surv. Prof. Paper no. 207, p. 84, pl. 37, figs. 3, 4, 1946. Magdalena Bay, Lower California to Panama. Recent. San Pedro district, Los Angeles Co., California, Pleistocene. — DuShane, Veliger (Berkeley, California), vol. 5, p. 43, July 1, 1962. Puertecitos, Baja California, Mexico. Recent.

Chione (*Nioche*) *picta* "Dall" Willett, Hertlein and Strong, Zoologica (New York, Zool. Soc.), vol. 33, pp. 187, 188, December 31, 1948. "Port Guatulco, Mexico, in 6-7 fathoms."

"*Chione*" *picta* "Dall" Willett, Valentine, Trans. San Diego Soc. Nat. Hist., vol. 12, p. 195, July 2, 1956. Potrero Canyon, Los Angeles Co., California. Pleistocene. — Valentine, Trans. San Diego Soc. Nat. Hist. vol. 12, p. 296, September 25, 1957. Near Punta Descanso, Baja California, Mexico. Pleistocene. — Kanakoff and Emerson, Contrib. Sci., Los Angeles Co. Museum, no. 13, pp. 22, 34 [table 1], October 14, 1959. Newport Bay, Orange Co., California. Pleistocene.

Chione (*Timoclea*) *picta* Willett, Keen, Sea Shells of Tropical West America (Stanford Univ. Press: Stanford, California), p. 146, fig. 335, 1958. Magdalena Bay, Lower California and southward to Panama, mostly offshore in depths to 7 fathoms. — McLean, Trans. San Diego Soc. Nat. Hist., vol. 12, p. 461, August 15, 1961. Los Angeles Bay, Baja California, Mexico. Recent.

Nioche (*Nioche*) *squamosa* (Carpenter), March, Molluscs of the Tropical Eastern Pacific (Paleo. Res. Inst.: Ithaca, New York), pp. 309, 310, March 10, 1961, pl. 49, fig. 10. Puerto Armuelles, Panama; Puerto Callo and Santa Elena, Ecuador; Zorritos and Bayovar, Peru. Recent.

[?] Not *Tapes squamosa* Carpenter, 1857.

Range. — Pleistocene to Recent. Recent from Magdalena Bay, Baja California, to Punta Peñasco, Sonora, Mexico, in the Gulf of California, and south to Bayovar, Peru.

Remarks. — Although this distinctive venerid is known from deposits of Pleistocene age in the Los Angeles basin of southern California and along the west coast of Baja California, Mexico, the present record, based on a single specimen, appears to be the first reported occurrence of this species as a fossil in the Gulf of California.

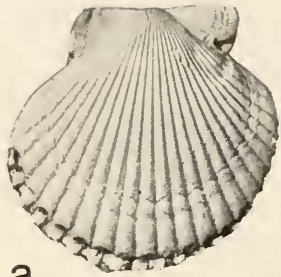
According to Keen (1958, p. 622), the type lot of *Tapes squamosa* Carpenter, which she examined in the British Museum (Natural History), "comprises two juvenile shells of which the larger may be a *Protothaca* sp. rather than an *Irus*" [= ?*Irus* (*Paphnotia*) *ellipticus* (Sowerby)]. Olsson (1961, p. 310), on the other hand, considered the unpublished drawings of *Tapes squamosa* for Carpenter's (1857) Mazatlán Catalogue to represent the species later described by Willett (1944), from a manuscript name of the late W. H. Dall,

Fig. 3. a-c, *Ostrea angelica* Rochebrune, 1895. a, b, F-1 (SD-BE), Isla Angel de la Guarda, ?Pliocene, height (beak to base) 90 mm., width 65 mm.; outside and inside views, respectively, of upper valve. c, 38539 (CAS), Isla Carmen, Pliocene, ventral view of both valves in place, length 55.5 mm., height 60.8 mm.

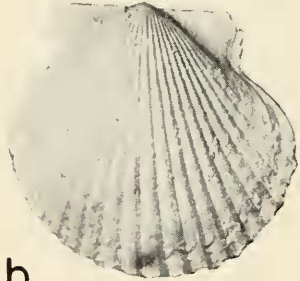
d-h, *Ostrea vespertina* Conrad, 1854, topotypes. d, e, 691 (CAS), east of Coyote Mountain, Imperial County, California, Pliocene; d, inside view of upper valve, length 23.4 mm., height 29.5 mm.; e, inside view of lower valve, length 26.2 mm., height 31 mm. f-h, 35010 (CAS), northeast side of Coyote Mountain, Imperial County, California, Pliocene; f, outside view of upper valve, length 34 mm., height 36 mm.; g, h, outside and inside views, respectively, of lower valve, length 48.5 mm., height 43 mm.

i, j, *Semele verrucosa* Mörch, 1860. F-5 (SD-BE), Isla Coronados, Pleistocene, length 59.5 mm., height 47 mm. (specimen incomplete). Outside and inside views, respectively, of right valve.

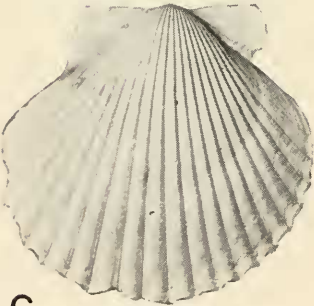
k, *Morula* (*Morunella*) *lugubris* (C. B. Adams), 1852. F-5 (SD-BE), Isla Coronados, Pleistocene, height 10 mm., diameter 4.8 mm., apertural view. Type species of *Morunella*, new subgenus.



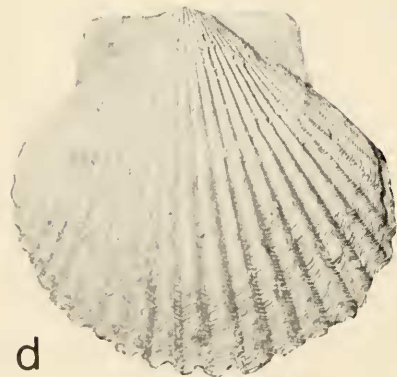
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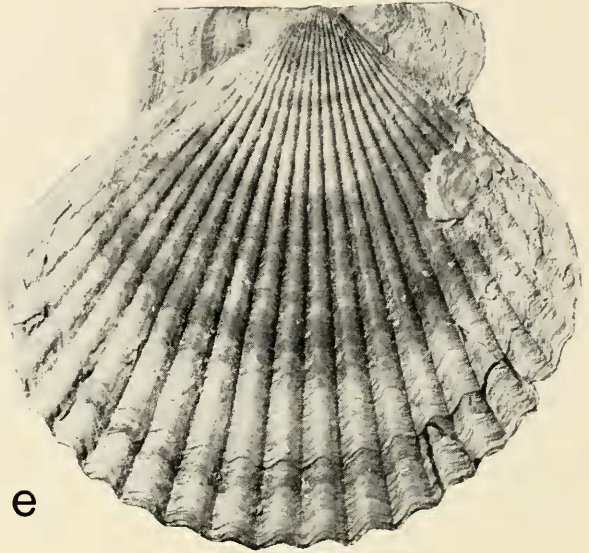
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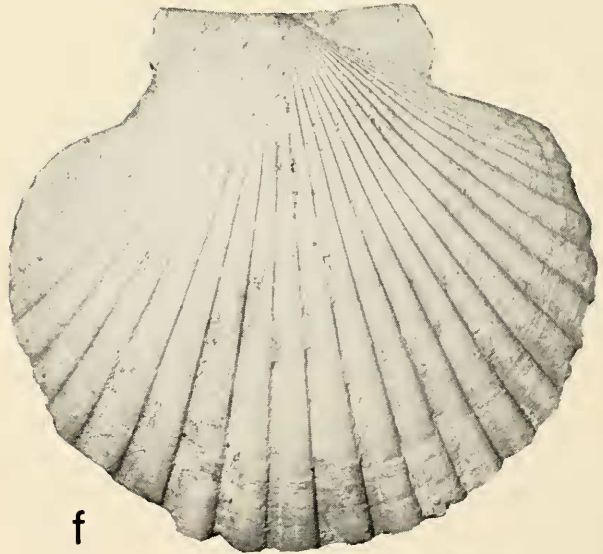
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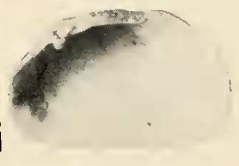
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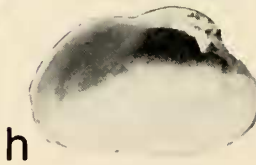
f



g



i



h



j

as "*Chione picta* Dall." The identity of Carpenter's taxon, however, can not be determined until one of the syntypes is designated the lectotype of *Tapes squamosa* Carpenter, 1857.

Family PETRICOLIDAE

Petricola (Petricola) robusta Sowerby, 1834

Petricola robusta Sowerby, Proc. Zool. Soc. London for 1834, p. 47, September 26, 1834. "Hab. ad Panaman et ad Insulam Muerte dictam." "Found in rocks at the depth of from six to eleven fathoms."—Sowerby, Thes. Conch., vol. 2, p. 775, pl. 166, figs. 16, 17, 1854. "In rocks, six to eleven fathoms, at Panama."—Sowerby, Conch. Icon., vol. 19, *Petricola*, species 20, pl. 3, figs. 20a, 20b, 1874. Panama.—Durham, Geol. Soc. America, Mem. 43, p. 87, pl. 23, fig. 15, 1950. Coronado Island and San Marcos Island; Pleistocene.

Petricola sinuosa Conrad, Proc. Acad. Nat. Sci. Philadelphia, vol. 4, p. 155, 1849. [No exact locality cited, title states "Shells from the coasts of Lower California and Peru."]

Petricola bulbosa Gould, Proc. Boston Soc. Nat. Hist., vol. 4, p. 88, November, 1851. "Inhabits Guaymas."—Gould, Otia Conch. (Gould and Lincoln: Boston), p. 210, 1862. "*Petricola bulbosa* [is *P. robusta*, Sowb.]."

Petricola venusta De Folin, Les Méléagrines, Soc. Havraise d'Études Diverses (Havre), p. 20, pl. 3, figs. 5-7, 1867. [Two localities cited (p. 9)] "les unes ont été pêchées aux environs des Negritos . . . les autres ont été prises autour des îles aux Perles, dans la Baie de Panama."

Petricola (Petricola) robusta Sowerby, Hertlein and Strong, Zoologica, New York, Zool. Soc., vol. 33, pt. 4, no. 13, p. 194, 1948. Gulf of California to Guayaquil, Ecuador.—Olsson, Mollusks of the Tropical Eastern Pacific (Paleo. Res. Inst.: Ithaca, New York), p. 315, pl. 54, figs. 2, 2a, 1961. Gulf of California to Caleta Sal, Peru.

Petricola (Rupellaria) robusta Sowerby, Keen, Sea Shells of Tropical West America (Stanford Univ. Press: Stanford, California), p. 152, fig. 348, 1958. Puerto Peñasco and the Gulf of California to Guayaquil, Ecuador, boring in hard clay.

Range.—Pleistocene to Recent. Recent from Punta Peñasco, Gulf of California, to Boca Pan and Caleta Sal, Peru, intertidal to 24 meters (13 fathoms).

Remarks.—Specimens of this species were collected from burrows in coral heads from Pleistocene deposits on Isla Coronados.

Petricola robusta was originally described from a tropical west American locality. It has been cited as occurring in South Africa by E. A. Smith (Ann. Natal Mus., vol. 1, pt. 1, p. 65, 1906), by Turton (Mar. Shells of Port Alfred, South Africa, p. 246, no. 1733, 1946) and more recently by Barnard (Beginner's Guide to South African Shells, p. 176, pl. 27, fig. 2, 1951), but Bartsch (U.S. Nat. Mus. Bull. 91, p. 247, 1915), who reported on the Turton Collection, pointed out that this is a Panamanian species and does not occur in South Africa.

Family SEMELIDAE

Semele verrucosa Mörch, 1860

Figures 3i, j

Semele (Amphidesma) verrucosa Mörch, Malakozool. Blätter, Bd. 7, p. 190, December, 1860. "Los Bocorones" Islands, Costa Rica.

Semele verrucosa Mörch, Hertlein and Strong, Zoologica, New York Zool. Soc., vol. 34, pt. 4, no. 19, p. 249, pl. 1, figs. 21, 24, December 30, 1949. Los Bocorones Islands, Costa Rica, to Hannibal Bank, Panama.—Keen, Sea Shells of Tropical West America (Stanford Univ. Press: Stanford, California), p. 202, fig. 504, 1958. Costa Rica to Panama, possibly intertidally, and to depths of 40 fathoms.—Olsson, Mollusks of the Tropical Eastern Pacific (Paleo. Res. Inst.: Ithaca, New York), p. 366, pl. 65, figs. 1-1b, March 10, 1961. Gulf of California to the Pearl Islands, Panama.

Fig. 4 a-e, *Chlamys (Argopecten) abietis* (E. K. Jordan and Hertlein, 1926). a, F-11 (SD-BE), Isla San José, Pliocene, right valve, length 46 mm., height 43.6 mm.; b, F-9 (SD-BE), Isla Monserrate, Pliocene, left valve, length 49.6 mm., height 46.5 mm., convexity 13.6 mm.; c, F-9 (SD-BE), Isla Monserrate, Pliocene, right valve, length 53.9 mm., height 50.9 mm., convexity 14.5 mm.; d, F-11 (SD-BE), Isla San José, Pliocene, left valve, length 66 mm., height 63.5 mm.; e, F-11 (SD-BE), Isla San José, right valve, length 128 mm., height 118 mm.

f, *Pecten (Patinopecten) marquerensis* (Durham), 1950. F-11, Isla San José, Pliocene, right valve, length 134 mm., height 120.5 mm.

g-j, *Basterotia (Basterotella) hertleini* Durham, 1950. F-6b (SD-BE), Puerto Ballandra, Isla Carmen. Pliocene. g, h, exterior and interior views, respectively, of left valve, length 12.2 mm., height 7.8 mm.; i, interior view of right valve, length 12.6 mm., height 7 mm.; j, exterior view of right valve, length 11.4 mm., height 7 mm.

Range. — Pleistocene to Recent. Recent from Los Bocorones Islands, Costa Rica, to the Pearl Islands, Panama, in 64-73 meters (35-40 fathoms). ?Gulf of California.

Remarks. — One right valve of this species, 60 mm. long and 46.5 mm. high, was collected from strata of Pleistocene age on Isla Coronados. The specimen retains much of the scaly, verrucose projections on the concentric ribs that are typical of this species.

This is the first fossil record for this species. We have not been able to verify the presence of living populations of this species in the Gulf of California (see Olsson, 1961:366).

Class GASTROPODA

Family BURSIDAE

Genus *Gyrineum* Link, 1807

Gyrineum Link, Beschreibung der Naturalien-Sammlung der Universität zu Rostock, p. 123, 1807. — Dall, 1904, Smithsonian Miscell. Colls., vol. 47, p. 131.

Type species. — *Murex gyrinus* Linné, 1758, by subsequent designation of Dall (1904).

Diagnosis. — Cymatiid species having a small to medium size, subovate shell, with two varices that are generally continuous and opposite and with a short, interiorly reflected, anterior canal; posterior canal obsolete, closed.

Remarks. — The type species is a common constituent of the modern Indo-Pacific faunal province.

The type designation by Rovereto (Atti Soc. Ligustica, vol. 10, pp. 101-110, 1899) of "*G.[yrineum] spinosum* Dillw.[yn]" is invalid, because that taxon was not included in the list of species originally assigned to *Gyrineum* by Link (1807).

Subgenus *Bechtelia*, new subgenus

Type species. — *Gyrineum strongi* Jordan, 1936, Pleistocene, west Mexico.

Diagnosis. — Shell similar to *Gyrineum*, but with the two varices interrupted by rounded nodos and with a short, nearly straight, open posterior canal.

Remarks. — Several *Gyrineum*-like species are known from west North American deposits, ranging in age from Eocene to Pleistocene. The type species of this new taxon appears to represent the evolutionary climax of this group in the Cenozoic deposits of this region, as no congeneric species are known at the present time from eastern Pacific waters.

We take pleasure in naming this subgenus in honor of Mr. K. K. Bechtel of San Francisco, California.

Gyrineum (Bechtelia) strongi Jordan, 1936

Figure 5g

Gyrineum strongi E. K. Jordan, Contrib. Dept. Geol. Stanford Univ., vol. 1, no. 4, p. 160, pl. 18, fig. 10, November 13, 1936. Loc. 982 (CAS), along beach, south of village, Magdalena Bay, Baja California, Mexico. Pleistocene. — Durham, Mem. Geol. Soc. Amer., no. 43, pp. 28, 115, pl. 29, figs. 19, 22, August 10, 1950. Loc. A-3550 (UCMP), Coronados Island. Pleistocene. Loc. A-3598 (UCMP), Concepcion Bay, Baja California. Pleistocene. Santa Rosalia area, Baja California. Pleistocene.

Range. — Pleistocene.

Remarks. — This distinctive species, which is not known to be living, was not previously reported from Islas Monserrate and San Diego. All records are from terrace deposits of apparently late Pleistocene age.

Family THAIDIDAE

Genus *Morula* Schumacher, 1817

Morula Schumacher, Essai d'une Nouveau Système des Habitations des vers Testacés, p. 227, 1817.

Type species. — *Morula papillosa* Schumacher, 1817 [= *Drupa uva* (Bolten) Röding, 1798], by monotypy.

Diagnosis. — Shell small, thick, sub-fusiform, spire elevated; aperture sub-linear, generally constricted by several singularly arranged labial teeth; columella typically with a prominent axial fold, this fold less commonly weakly developed or completely lacking; radula similar to *Drupa (sensu stricto)* but base of central tooth modified, margins generally smooth or wrinkled, without true denticles; operculum similar to that of *Drupa*.

Remarks.— On shell characters alone, some members of this group are difficult to separate from *Drupa* (*sensu lato*). In *Morula* the shell tends to be more fusiform in shape than the somewhat oval shell of *Drupa* (*sensu stricto*). There are also several major differences in the radular structure of the two groups. The base of the central tooth in *Morula* is medially convex instead of being straight or concave as in *Drupa* (*s.s.*). The medial bulge is actually the base of the central cusp, which, unlike *Drupa* (*s.s.*), extends the entire width of the central tooth as a heavy, raised rod. The margins of the central teeth are never denticulate, but have denticle-like wrinkles that indent the margin and terminate marginally as small serrations. The radula in species of the subgenus *Drupella* Thiele is greatly modified.

Subgenus *Morunella*, new subgenus

Type species.— *Buccinum lugubre* Adams, 1852.

Diagnosis.— Surface of shell finely nodose; edge of labrum sharp, thickened within by a ridge possessing several lirae, each of which terminates in minute, labial denticles.

Remarks.— Although the type species was originally placed in the Buccinidae and was subsequently referred to the Fascioliariidae, Fusinidae and Muricidae, it appears to be referable to the Muricea and to be most closely allied with the genus *Morula* of the subfamily Drupinae.

Morula (*Morunella*) *lugubris* (C. B. Adams), 1852

Figure 3k

Buccinum lugubre Adams, Ann. Lyceum Nat. Hist. New York, vol. 5, p. 293, June, 1852. "Panama, and Taboga." Recent.— Adams, Catalogue of Shells collected at Panama with Notes on Synonymy, Station and Geographic Distribution (New York), p. 293 (separate p. 69), 1852.— Turner, Occas. Papers Moll., vol. 2, p. 61, pl. 5, fig. 7, [type specimen] September 22, 1956.— Hertlein, Veliger (Berkeley, California), vol. 3, p. 8, July 1, 1960.

Lairus lugubris C. B. Adams, Pilsbry and Lowe, Proc. Acad. Nat. Sci. Philadelphia, vol. 83, p. 114, May 21, 1932. Guaymas, Mazatlán, and Acapulco, Mexico and San Juan del Sur, Nicaragua. Recent.— Lowe, Trans. San Diego Soc. Nat. Hist., vol. 8, p. 30. Punta Peñasco, Mexico. Recent.

Fusinus luteopictus (Dall) Willett [in part, *vide* Burch, 1940, and others], Trans. San Diego Soc. Nat. Hist., vol. 8, p. 396, December 15, 1937. Baldwin Hills, near Playa del Rey, California. Pleistocene. Not *Fusinus luteopictus* Dall, 1877.

Cantharus lugubris C. B. Adams, Burch, T., Nautilus, vol. 54, p. 47, pl. 2, figs. 5-7, October, 1940. Off Catalina Island and Redondo Beach, California; and Playa del Rey, California, Pleistocene.

Drupa lugubris C. B. Adams, Burch, T., Minutes Conchol. Club South. Calif., no. 17, p. 7, November, 1942. Redondo Beach, California.— Burch, J. Q. [editor], *Ibid.*, no. 52, p. 10, September, 1945. Redondo Beach, California to Panama. Recent. Baldwin Hills, Los Angeles Co., California. Pleistocene [specimens confused with *Fusinus*].

Morula lugubris (C. B. Adams), Keen, Sea Shells of Tropical West America, p. 376, fig. 412, 1958. San Diego, California, to Panama. Recent.— Emerson and Chace, Trans. San Diego Soc. Nat. Hist., vol. 12, pp. 338, 342, May 27, 1959. Tecolote Creek, San Diego, California. Pleistocene.— DuShane, Veliger (Berkeley, California) vol. 5, p. 47, July 1, 1962. Puertecitos, Baja California, Mexico. Recent.

Range.— Pleistocene to Recent. Recent from off Catalina Island and Redondo Beach, California; Punta Peñasco, Sonora, Mexico, in the Gulf of California, and south to Panama.

Remarks.— The present specimen apparently is the first fossil record for this species in the Gulf of California. This species was previously reported from Pleistocene deposits in the Los Angeles and San Diego basins of southern California, and the species is known to range at the present time from southern California to Panama.

A very similar species, *Morula* (*Morunella*) *didyma* (Schwengel) was described from 200 feet, off Palm Beach, Florida (Schwengel, Nautilus, vol. 56, pp. 76, 77, pl. 7, fig. 7, 1943) and is also reported from St. Croix, Virgin Islands (Nowell-Usticke, A Check List of the Marine Shells of St. Croix, p. 63, 1959), from off the coast of Texas in 24-31 fathoms (Parker and Curray, Bull. Amer. Assoc. Petrol. Geol., vol. 40, p. 2433, pl. 1, fig. 7, 1956), and from Bocas Island, east Panama (Olsson and McGinty, Bull. Amer. Paleont., vol. 39, p. 15, 1958). The western Atlantic form may prove to be merely a subspecies of *M. lugubris*.

Family CANCELLARIIDAE

Cancellaria (Aphera) wigginsii, new species

Figures 5d, e

Holotype.—No. 12607, California Academy of Sciences Department of Geology type collection, from Loc. 38554 (CAS), west side of Isla Monserrate, Baja California, Mexico, in the Gulf of California; Pleistocene; Ira L. Wiggins, collector, April 8, 1962.

Description.—Shell ovate, six rounded whorls, the body whorl much larger than the spire; the first two and one half nuclear whorls smooth, the third, fourth and fifth whorls sculptured with seven or eight fine concentric riblets gradually increasing in coarseness, the body whorl bearing 25 or 26 spirals which are crossed by longitudinal, raised lines of growth which lend a pitted appearance to the sculpture; aperture ovate, inner margin of outer lip bearing about 12 denticles, the third posterior one the largest, which extend inward as short lirae; inner lip covered with a broad, thick callus, the upper portion of which is very faintly longitudinally grooved; columella with two well developed plications, the upper one the larger.

Measurements of type.—Length, 26.7 mm.; maximum diameter, 14.2 mm.; length of body whorl, 19.5 mm.

Remarks.—This new species bears a resemblance to species described from strata of Miocene age in the Caribbean region and in Peru. *Cancellaria (Aphera) wigginsii* differs from *C. (A.) islacolonis* Maury (Bull. Amer. Paleont., vol. 5, p. 229 [65], pl. 36 [10], figs. 12, 12a, 12b, 1917) described from Miocene beds in Santo Domingo, in the more slender outline, the thicker callus on the body whorl, the lack of grooving on the columellar plications, and in the absence of a denticle on the upper portion of the columellar wall. *Cancellaria (A.) ellipsis* Pilsbry (Proc. Acad. Nat. Sci. Phila., vol. 73, p. 333, pl. 22, figs. 8, 9, 1922), a small form 12 mm. in length, also described from Miocene beds in Santo Domingo, may be a juvenile form of the species described by Maury, as mentioned by Pilsbry.

The shell characters separating *C. (A.) wigginsii* from *C. (A.) islacolonis* also serve to separate it from *C. (A.) peruana* Nelson (Trans. Conn. Acad. Sci., vol. 2, no. 1, p. 190, pl. 6, fig. 3, 1870; Spieker, Johns Hopkins Univ. Stud. Geol., no. 3, p. 42, pl. 4, fig. 13, 1922), which also has a more globose form and coarser sculpture.

Cancellaria (Aphera) tessellata Sowerby (Proc. Zool. Soc. London, p. 51, June, 1832; Conch. Illustr., Cat. p. 3, January 11, 1833, pl. 11, figs. 20, 20*, December 21, 1832), living in tropical west American waters, is very much more slender in outline in comparison to *C. (A.) wigginsii* and to its Miocene relatives.

A second Recent species of the genus *Cancellaria* and the subgenus *Aphera* occurs in the Panamic faunal province, namely *C. (A.) oblonga* Sowerby, 1825.

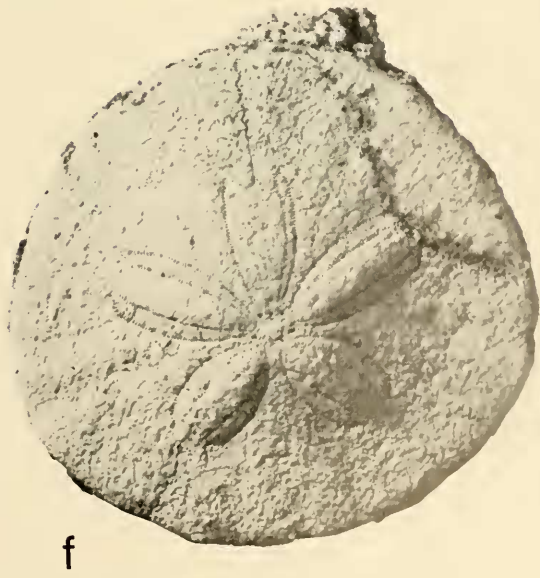
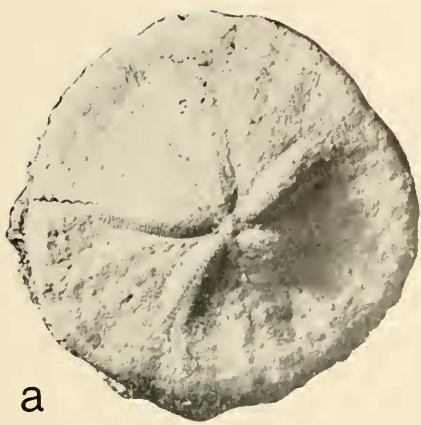
We take pleasure in naming this species in honor of Dr. Ira L. Wiggins, Professor of Biology, Emeritus, Stanford University.

Fig. 5. a-c, *Dendraster casseli* Grant and Hertlein, 1938. F-11 (SD-BE), Isla San José, Pliocene. a, greater diameter 53.5 mm., lesser diameter (anterior-posterior) 52.1 mm., abactinal view; b, greater diameter (anterior-posterior) 44.6 mm., lesser diameter 43 mm., actinal view; c, greater diameter (anterior-posterior) 36 mm., lesser diameter 35 mm., abactinal view.

d, e, *Cancellaria (Aphera) wigginsii*, new species. 38554 (CAS), Isla Monserrate, Pleistocene, holotype, length 26.7 mm., maximum diameter 14.2 mm. d, dorsal view; e, apertural view. (Photos by A. G. Smith).

f, *Dendraster* cf. *D. granti* Durham, 1950, Isla San José, lesser diameter 68.5 mm., greater diameter 72.5 mm., abactinal view.

g, *Gyrineum (Bechtelia) strongi* Jordan, 1936. F-10 (SD-BE), Isla Monserrate, Pleistocene, height 57 mm. (spire incomplete), maximum diameter 29 mm., apertural view. Type species of *Bechtelia*, new subgenus.



Family CONIDAE

Conus (Chelyconus) patricius Hinds, 1843

Conus patricius Hinds, Ann. Mag. Nat. Hist., new ser., vol. 11, p. 256, April, 1843. "Gulf of Nicoya, Central America . . . in 7 fathoms".—Hertlein and Strong, Bull. Amer. Mus. Nat. Hist., vol. 107, p. 218, November 28, 1955. Piñas Bay, Panama; Ardita Bay and Bahía Cuevita, Colombia.—Hertlein in Brandt, Coastal Study of southwest Mexico, pt. 2, p. 248, Dept. Geogr. Univ. Texas, 1958. Coast of Michoacán.—Shasky, Minutes Conchol. Club, South. Calif., no. 186, March, 1959. West Mexico.—Hanna, Occas. Papers, Calif. Acad. Sci., no. 35, pp. 49, 51, pl. 6, figs. 1-10; pl. 8, fig. 1; pl. 10, figs. 4, 5, January 28, 1963. Michoacán, Mexico, south to Punta Carnero, Ecuador. Recent.

Conus pyriformis Reeve, Conch. Icon., vol. 1, *Conus* pl. 13, fig. 70, May, 1843. "Bays of Caraccas and Montija, West Columbia."

Conus (Dendroconus) patricius Hinds, Keen, Sea Shells of Tropical West America (Stanford Univ. Press: Stanford, California), p. 484, fig. 934, 1958. Nicaragua south to Ecuador. Recent.

Range.—Pleistocene to Recent. Recent from Michoacán, Mexico, to Punta Carnero, Ecuador.

Remarks.—One beautifully preserved specimen, measuring nearly 90 mm. in length, was collected in the richly fossiliferous Pleistocene sands at Isla Monserrate. Although this species is known from the Pleistocene of Ecuador (Rivera, 1953, Minutes Conchol. Club So. Calif., no. 129, p. 14), this appears to be the first fossil record from Mexico for this species, which is not known to be living at the present time in the Gulf of California.

Recently cited by Keen (1958) to range southward from Nicaragua, this species is now known to occur in Mexican waters. Hertlein (1958) and Hanna (1963) report it to be living as far north as the Mexican State of Michoacán, and Shasky (1959) records a specimen from an unknown locality along the west Mexican coast. In 1960, Mr. Frederick D. Sibley collected living specimens at Revolcadero Beach, near Acapulco, Guerrero, Mexico (AMNH collection).

Phylum ECHINODERMATA

Class ECHINOIDEA

Family CLYPEASTRIDAE

Clypeaster bowersi Weaver, 1908

Clypeaster bowersi Weaver, Univ. Calif. Publ. Bull. Dept. Geol., vol. 5, no. 17, p. 271, pl. 21, fig. 1; pl. 22, fig. 1, 1908. "Colorado Desert." Presumed to be of Miocene age.—Kew, Univ. Calif. Publ. Bull. Dept. Geol., vol. 8, no. 5, p. 50, pls. 4 and 5, April 16, 1914. "Lower Division of the Carrizo formation at Coyote Mountain."—Clark and Twitchell, U. S. Geol. Surv., Monogr. 54, p. 209, pl. 96, figs. 1a and 1b, 1915. "Colorado Desert (Weaver)."—Kew, Univ. Calif. Publ. Bull. Dept. Geol., vol. 12, no. 2, p. 58, pl. 5, figs. 1a and 1b; pl. 6, fig. 1, 1920. "Coyote Mountain, Imperial County, California." "Lower Division of the Carrizo Creek beds, Pliocene."—G. D. Hanna, Proc. Calif. Acad. Sci., Fourth Ser., vol. 14, no. 18, p. 479, 1926. Several localities cited from Coyote Mountain, Imperial County, California and neighboring region, Pliocene.—Grant and Hertlein, Univ. Calif. Los Angeles Math. Phys. Sci., vol. 2, p. 43, 1938. Earlier records cited. Pliocene.—Shimer and Shrock, Index Fossils of North America (John Wiley & Sons, Inc.: New York), p. 221, pl. 84, figs. 17, 18, 1944. (Copies of Kew's illustrations, 1920). "Plioc.: Cal. (Carrizo); L. Cal., Mex."—Durham, Geol. Soc. America, Mem. 43, pt. 2, p. 40, pl. 42, fig. 9; pl. 46, figs. 1, 2, 1950. "Lower? Pliocene from mainland southeast of San Marcos Island, some distance west of Chivato Point." Also Santa Antonita Point, Baja California. Pliocene.

Clypeaster testudinalis Gray, Hanna and Hertlein, Proc. Calif. Acad. Sci., Fourth ser., vol. 16, no. 6, pp. 140, 145, 153 (as *Clypeaster testudinarius*), April 22, 1927. One half mile back from shore at Santa Antonita, Baja California; Pliocene.

Not *Echinanthus testudinarius* Gray, Proc. Zool. Soc. London for 1851, p. 35. "Hab. Indian Ocean; Borneo." (See also Hertlein and Grant, 1938, p. 43, footnote 47).

Range.—Early (Durham) and Mid-Pliocene of the Gulf of California region and Imperial County, California.

Remarks.—Two specimens of a huge *Clypeaster* were collected by Ira Wiggins from beds of Pliocene age on Isla Cerralvo. One of these is 168.2 mm. long. The petals on one side of the abactinal surface are visible, and these as well as other observable shell characters agree with those of specimens of *Clypeaster bowersi* Weaver from Imperial County, California, and others from Baja California. Another large, but crushed, specimen from the same locality is imperfectly preserved; it is, however, apparently referable to *C. bowersi*.

One specimen in the present collection, collected by Emerson at El Mostrador on Isla Cerralvo F-13 (SD-BE), is partly covered with matrix, but the shape and observable shell characters agree well with those of *C. bowersi*.

The record of *Clypeaster bowersi* Weaver by Royo Gomez (Comp. Estud. Geol. Colombia, Tomo 5, p. 469, 1942) from beds of late Tertiary age in Colombia is probably referable to a similar but different species.

Family SCUTELLIDAE

Dendraster casseli Grant and Hertlein, 1938

Figures 5a-c

Dendraster casseli Grant & Hertlein, Univ. Calif. Publ. Math. and Phys. Sci., vol. 2, p. 81, pl. 1, figs. 1, 2; pl. 30, fig. 3, April 19, 1938. From "Loc. 356 (UCLA), at head of ravine in SE. corner of Sec. 10, T. 4N., R. 17W., S.B.B. & M., about 0.2 mi. N. of corner, in the *Dendraster* bed, elevation 1300 feet by contour (U.S. Geol. Surv. Topog. Map of Santa Susana Quadrangle)." — Hertlein and Grant, Mem. San Diego Soc. Nat. Hist., vol. 2, pt. 2a, p. 120, pl. 27, fig. 7 (San Diego formation, middle Pliocene), July 7, 1960. Earlier record (1938) from San José Island cited.

Range. — Mid-Pliocene, southern California, and Isla San José, Gulf of California.

Remarks. — More than 40 specimens ranging from 11 to 53 mm. in greatest diameter were collected on Isla San José. This species was previously reported from strata of Pliocene age on this island by Grant and Hertlein (1938:82).

The apical system of this species is only slightly excentric and the ambulacral petals are long, nearly straight, narrow, open at the ends, and raised above the general surface of the test.

Dendraster cf. *D. granti* Durham, 1950

Figure 5f

[?] *Dendraster granti* Durham, Geol. Soc. America, Mem. 43, pt. 2, p. 41, pl. 47, figs. 3-12. August 10, 1950. From Loc. A 3559 (Univ. Calif.), "Middle (?) Pliocene, Arroyo de Arce, north of Arroyo de Gua, Lower California. In cliff along north side of arroyo. Estimated to be about three quarters of a mile from beach. Stratigraphically higher than unconformity in section. In low-dipping alternating gravels and leached calcareous beds."

Range. — Mid-Pliocene (Durham), Baja California, Mexico and ?Isla San José, Gulf of California.

Remarks. — The present record is based upon a *Dendraster* which is 68 mm. long (anterior-posterior) and 72 mm. wide. The general characters of the test agree with those described for *D. granti*, and it occurs in beds of about the same age.

The type specimen of *Dendraster granti* is only 35.7 mm. long and 37 mm. wide. It was compared with *D. vizcainoensis* Grant and Hertlein (1938, p. 90, pl. 8, figs. 1, 2, and 3), a species described from a terrace deposit of Quaternary age at Punta Santa Rosalía in Bahía de Sebastian Vizcaino, Baja California. The test of the present specimen is raised centrally, and the petals are elevated above the surface of the test, which bears large, rather widely spaced tubercles.

The petals of *D. granti* were described as "ovate, almost parallel-sided." The illustrations of it reveal variation in the curvature of the sides of the petals. The sides of the petals of the bivium in the present fossil are decidedly curved (fig. 5f). It seems probable that this specimen represents a large form of *D. granti*.

The present specimen also bears a decided resemblance to *Dendraster vizcainoensis similis* Grant and Hertlein (1938, p. 90, pl. 27, figs. 1, 2; pl. 28, fig. 8), described from beds of late Pleistocene age in the vicinity of Los Cerritos Station, near Signal Hill, Long Beach, California. The type specimen is 88 mm. long and 93 mm. wide. The petals of the bivium of that subspecies are a little more ovate and the test is more elevated centrally than those of present specimen from Isla San José, but otherwise the resemblance is remarkable.

Encope californica Verrill, 1870

Figures 6a-e

Encope californica Verrill, Amer. Jour. Sci., Ser. 2, vol. 49, p. 97, January, 1870. "La Paz" and "Cape St. Lucas", "Gulf of California." Recent. — Grant and Hertlein, Univ. Calif. Publ. Math. and

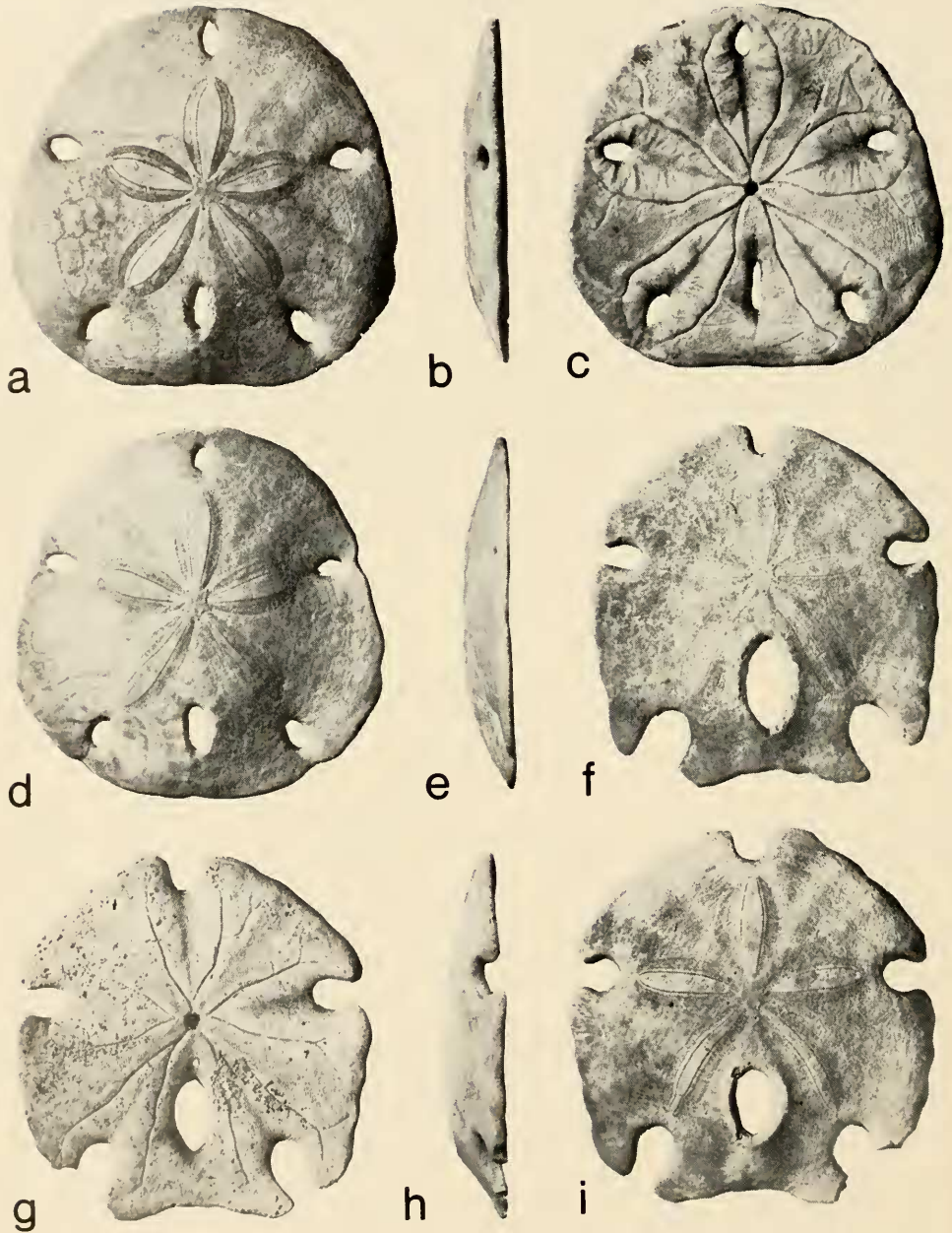


Fig. 6. a-e, *Encope californica* Verrill, 1870. F-10 (SD-BE), Isla Monserrate, Pleistocene. a-c, height (anterior-posterior) 97 mm., width 98.5 mm.; a, abactinal view; b, side view; c, actinal view. d, e, height 95 mm., width 93 mm.; d, abactinal view; e, side view.

f-i, *Encope grandis* L. Agassiz, 1841. F-10 (SD-BE), Isla Monserrate, Pleistocene. f, g, height (anterior-posterior) 95 mm., width 93 mm.; f, abactinal view; g, actinal view; h, i, height (anterior-posterior) 99.5 mm., width 96.3 mm.; h, side view; i, abactinal view.

Phys. Sci., vol. 2, p. 96, pl. 11, fig. 4, pl. 30, fig. 2, April 19, 1938. From [about $1\frac{1}{8}$ mile southwest of the eastern tip of] Punta Santa Ynez, Gulf coast of Lower California, Mexico. Pleistocene. — Durham, Geol. Soc. America, Mem. 43, pt. 2, p. 44, pl. 37, fig. 2; pl. 38, figs. 1, 5, August 10, 1950. Range, lower Pliocene to Recent.

Range. — Early Pliocene (Durham) to Recent. Recent from San Luis Gonzaga Bay, Baja California, to La Paz, Baja California, Mexico.

Remarks. — This echinoid occurs frequently in beds of Pliocene and Pleistocene age in the Gulf of California region. The test is highest posteriorly at the anterior end of the interambulacral lunule. The margin of this species is much thicker and the lunules are closed in contrast to the similar *Encope carrizoensis* Kew, which was originally described from strata of Pliocene age in Imperial County, California. The test of *Encope grandis* Agassiz is highest posteriorly, like that of *E. californica*, but the margin is much thicker, the marginal lunules are open, and the interambulacral lunule is much larger (see fig. 6).

A. H. Clark (Smithson. Miscell. Coll., vol. 106, no. 5, p. 6, 1946) believed *Encope californica* to be "a localized race confined to the Gulf of California" and H. L. Clark (Allan Hancock Pac. Exped., vol. 8, no. 5, p. 329, 1948), placed it in the synonymy of *Encope micropora* Agassiz, which was originally described without a type locality. Durham (1950) considered *E. californica* to be a valid species, and Mortensen (Mon. Echin., IV, 2, Clypeastroidea, p. 445, 1948) recognized it as a subspecies or variety of *E. micropora*.

Literature Cited¹

ANONYMOUS

1924. Informe sobre la exploración geológica de la Baja California, por la Marland Oil Company of Mexico. Bol. del Petroleo, vol. 17, no. 6, pp. 417-453, pls. 1, 4-12, 14-22, 26-46, June; vol. 18, no. 1, pp. 14-53, pls. 77-92, 1 map, July.

ANDERSON, C. A.

1950. 1940 E. W. Scripps cruise to the Gulf of California. Pt. 1. Geology of islands and neighboring land areas. Mem. Geol. Soc. Amer., no. 43. 53 pp.

BEAL, C. H.

1948. Reconnaissance of the geology and oil possibilities of Baja California, Mexico. Mem. Geol. Soc. Amer., no. 31. x + 138 pp., 11 pls.

DURHAM, J. W.

1950. 1940 E. W. Scripps cruise to the Gulf of California. Pt. 2. Megascopic paleontology and marine stratigraphy. Mem. Geol. Soc. Amer., no. 43. viii + 216 pp.

DURHAM, J. W., AND E. C. ALLISON

1960. The geologic history of Baja California and its marine faunas. in The biogeography of Baja California and adjacent seas. Pt. 1. Geologic history. Syst. Zool. 9:47-91.

DURHAM, J. W., AND J. L. BARNARD

1952. Stony corals of the eastern Pacific collected by the *Velero III* and *Velero IV*. Allan Hancock Pacific Expeditions 16:1-110.

EMERSON, W. K.

- 1960a. Results of the Puritan-American Museum of Natural History expedition to western Mexico. 11. Pleistocene invertebrates from Cerralvo Island. Amer. Mus. Novitates no. 1995. 6 pp.
- 1960b. Results of the Puritan-American Museum of Natural History Expedition to western Mexico. 12. Shell middens of San José Island. Amer. Mus. Novitates no. 2013. 9 pp.

¹Excluding references cited in the Systematic Treatment section

EMERSON, W. K., AND M. K. JACOBSON

1964. Terrestrial mollusks of the Belvedere expedition to the Gulf of California. *Trans. San Diego Soc. Nat. Hist.* 13:313-332.

GREWINGK, C.

1848. Beitrag zur Kenntniss der Geognostischen Beschaffenheit Californiens. *Verhandlungen der Russisch-Kaiserlichen Mineralog. Gesellschaft zu St. Petersburg*, "1847", pp. 143-162.

GRANT, U. S., IV, AND L. G. HERTLEIN

1938. The west American Cenozoic Echinoidea. *Publs. Univ. Calif. Los Angeles in Math. and Phys. Sci.*, Vol. 2. vi + 226 pp.

HANNA, G D.

1926. Paleontology of Coyote Mountain, Imperial County, California. *Proc. Calif. Acad. Sci.*, ser. 4, 14:427-503.

HANNA, G D., AND L. G. HERTLEIN

1927. Expedition of the California Academy of Sciences to the Gulf of California in 1921. *Geology and Paleontology. Proc. Calif. Acad. Sci.*, ser. 4, 16:137-157, pl. 5.

HERTLEIN, L. G.

1957. Pliocene and Pleistocene fossils from the southern portion of the Gulf of California. *Bull. So. Calif. Acad. Sci.* 56:57-75, pl. 13.

HERTLEIN, L. G., AND W. K. EMERSON

1956. Marine Pleistocene invertebrates from near Puerto Penasco, Sonora, Mexico. *Trans. San Diego Soc. Nat. Hist.* 12:154-176.
1959. Results of the Puritan-American Museum of Natural History expedition to western Mexico. 5. Pliocene and Pleistocene megafossils from the Tres Marias Islands. *Amer. Mus. Novitates* no. 1940. 15 pp.

LINDSAY, G. E.

1962. The Belvedere expedition to the Gulf of California. *Trans. San Diego Soc. Nat. Hist.* 13:1-44.

SQUIRES, D. F.

1959. Results of the Puritan-American Museum of Natural History expedition to western Mexico. 7. Corals and coral reefs in the Gulf of California. *Bull. Amer. Mus. Nat. Hist.* 118:367-432, pls. 28-34.

TARBET, L. A., AND W. H. HOLMAN

1944. Stratigraphy and micropaleontology of the west side of Imperial Valley, California. *Bull. Amer. Assoc. Petrol. Geol.* 28:1781-1782 [Abstract].

WILSON, I. F.

1948. Buried topography, initial structures, and sedimentation in Santa Rosalía area, Baja California, Mexico. *Bull. Amer. Assoc. Petrol. Geol.* 32:1762-1807.

WILSON, I. F. [in collaboration with V. S. ROCHA]

1955. Geology and mineral deposits of the Boleo Copper District, Baja California, Mexico. *U. S. Geol. Surv. Prof. Paper* 273. vi + 134 pp., 11 pls.